Clearlake System
Water Master Plan

Golden State Water Company

December 2019

Executive Summary

Purpose

The purpose of this Master Plan is to assess Golden State Water Company's (GSWC) Clearlake System's ability to meet current and future water needs, and to identify upgrades needed if deficiencies exist. This assessment is developed by using hydraulic analysis criteria, future demands and available supply, water quality standards, and condition of facilities.

These updates provide GSWC with a basis to determine the impacts of new development on the existing system and to identify system deficiencies and improvements needed to correct them. These system improvement needs are used as the basis for developing the Capital Improvement Program (CIP) for the system. TABLE 9-1 summarizes the CIP projects identified in this master plan.

GSWC's goal is to meet the minimum requirements identified in the technical memorandum titled *Golden State Water Company Master Planning Criteria and Standards* (see Appendices).

Master Plan Process

This master plan document is organized as follows:

- Update existing system information
- Establish existing demands and forecast future demands
- Update system's hydraulic model
- Evaluate supply and storage capacities
- Perform hydraulic analyses and evaluation
- Identify water quality issues
- Assess condition of facilities in the system
- Develop CIP

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Acronyms and Abbreviations

1,1-DCE	1,1-dichloroethylene
2016 WMP	Clearlake 2016 Water Master Plan
AACE International	Association for the Advancement of Cost Engineering International
ADD	average day demand
AFY	acre-feet per year
amsl	above mean sea level
AOB	ammonia-oxidizing bacteria
CIP	capital improvement program
CPUC	California Public Utilities Commission
DDW	State Water Resources Control Board, Division of Drinking Water
DPB Rule	Disinfectants and Disinfection Byproducts Rule
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FCV	flow-control valve
fps	foot or feet per second
GAC	granular activated carbon
gpm	gallons per minute
GSWC	Golden State Water Company
GWO	General Work Order
HPC	heterotrophic plate count
IDSE	Initial Distribution System Evaluation
MCL	maximum contaminant level
MDD	maximum day demand
MG	million gallons
MHD	minimum hour demand
NAICS	North American Industry Classification System
NOB	nitrite-oxidizing bacteria

O&M	operations and maintenance
PCE	tetrachloroethylene
PHD	peak hour demand
PRV	pressure-regulating valve
psi	pounds per square inch
PSV	pressure-sustaining valve
SCADA	supervisory control and data acquisition
SDWA	Safe Drinking Water Act
TDS	total dissolved solids
TTHM	total trihalomethanes
UDF	uni-directional flushing
VOC	volatile organic compound
WMP	Water Master Plan

SECTION 1
Introduction

1.1 Overview of Golden State Water Company

GSWC is a subsidiary of American States Water Company, an investor-owned utility dedicated to increasing value through the expert management of utility assets and services. As a public utility, GSWC is committed to the purchase, production, distribution, and sale of water to over 260,000 customer connections.

GSWC is organized into three regions throughout the state of California. Region I is located in northern and central coast of California. Region II serves communities in Los Angeles County. Region III serves communities in Los Angeles, San Bernardino, Imperial, and Orange counties.

FIGURE 1-1, provided at the end of this section, shows the locations of all GSWC water systems.

1.2 Master Plan Update

The purpose of this master plan is to assess the Clearlake System's ability to meet current and future water needs and recommend system upgrades needed to meet current customer needs. This assessment is developed by using hydraulic design criteria, water quality standards, system demands and available supply, and facility condition assessments.

Specifically, this master plan supports GSWC's effort to update existing master plans and hydraulic models for water systems throughout the company. These updates provide GSWC with a baseline for determining the impacts of new development on existing systems as well as identifying short, mid, and long term system needs. These system needs are used as the basis for developing the capital improvement program (CIP) for the system. The primary drivers of this master plan update are the following:

- Assess the distribution system's hydraulic performance
- Identify infrastructure that is in poor condition and needs to be replaced
- Identify supply and storage needs
- Identify water quality and treatment needs
- Provide documentation for the proposed CIP projects in support of the General Rate Case for the California Public Utilities Commission (CPUC)
- Reduce operations and maintenance (O&M) efforts and costs required to maintain service under current conditions
- Minimize service failures

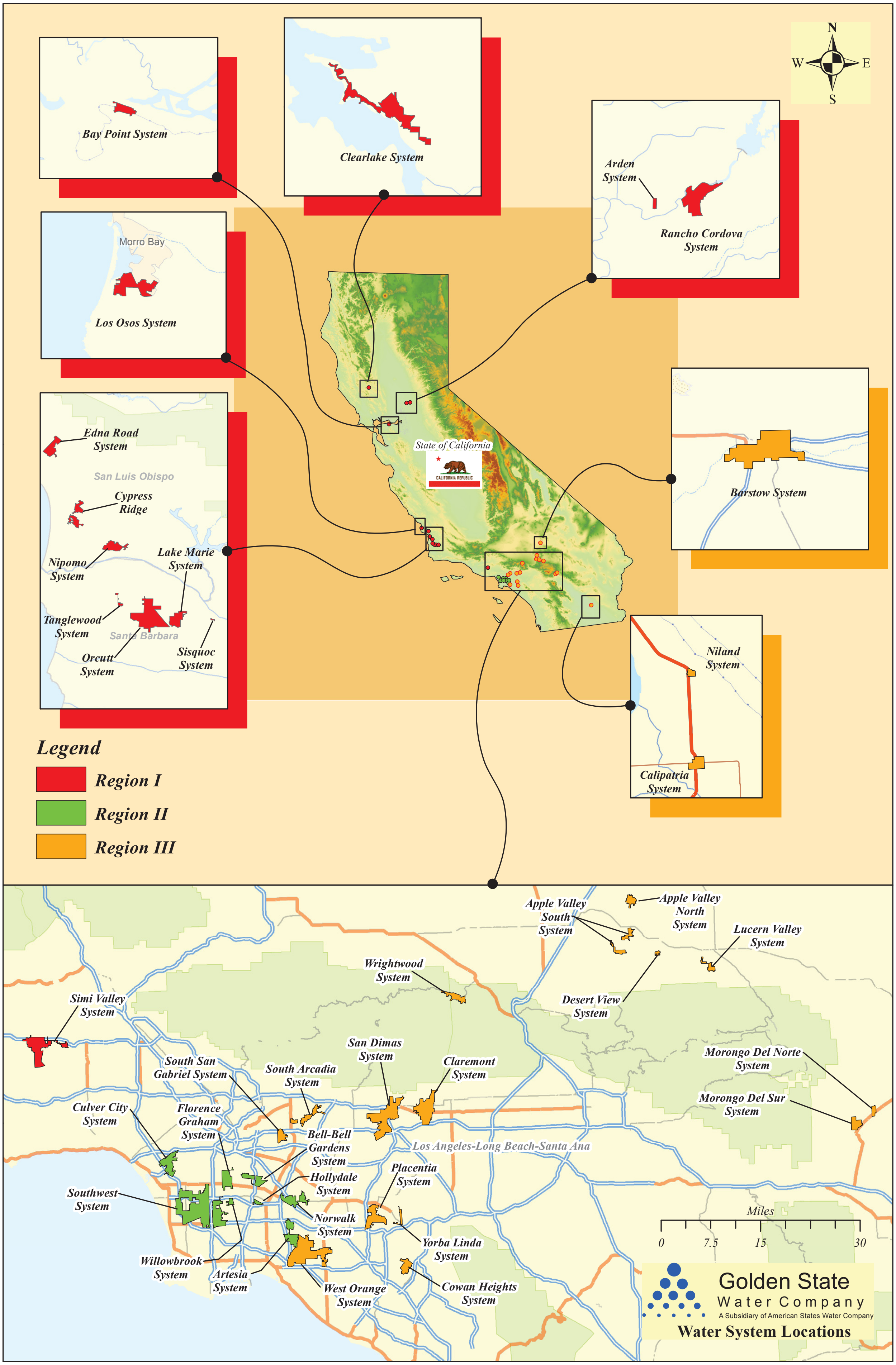
1.3 Document Organization

This master plan document is organized to provide information in a sequential manner that considers historical progression (past to present to future) and logical evaluation of the system from existing facilities and requirements through future needs. Each section's title and a brief summary are as follows:

1. **Introduction:** Provides background information on the company and its systems.
2. **Existing Water System Facilities:** Provides an overview of the system and its facilities. System facilities identified include the system service area boundary, pressure zones, distribution areas, supply sources, storage facilities, pump stations, pressure regulating and water control stations, and transmission and distribution pipelines.
3. **Existing and Future Demands:** Provides definition of demand types and periods, as well as existing and future demands. Explains the demand development approach and determination of peaking factors. Provides the current demands and projected demands developed for a future 2040 condition. Future demands are based on population growth rate and water use projections.
4. **Hydraulic Model Development and Calibration:** Provides an overview of the modeling process, including hydraulic model construction and calibration.
5. **Supply and Storage Capacity Evaluation:** Documents the evaluation of the system's water supply and storage capacity using the objectives identified in GSWC's *Master Planning Criteria and Standards.* The evaluation results establish supply and storage needs for each distribution area and the entire distribution system. Existing and future supply and storage deficiencies are also identified. Recommended improvements to mitigate deficiencies are also provided.
6. **Hydraulic Analysis and Evaluation:** Outlines the approach for the hydraulic analysis. Details how the updated hydraulic model was used to determine hydraulic deficiencies under simulated demand scenarios and was compared with the analysis and planning criteria for short, mid, and long term planning periods. Provides recommendations to address deficiencies that were identified. Scenarios simulated by the hydraulic model include average day, maximum day, and peak hour conditions.
7. **Water Quality Analysis:** Provides GSWC's evaluation of water quality based on current and pending federal and state standards and rules.
8. **System Condition Assessment:** Provides GSWC's documentation of system condition assessment efforts including past efforts, recent field inspections, and recommendations for future improvements.
9. **Capital Improvement Program:** Describes the CIP plan resulting from all preceding tasks broken down into short, mid, and long term planning periods. This includes prioritization and justification for the projects included in the CIP.
10. **References:** Lists the primary sources of information referred to throughout the master plan.

Appendices provide supporting information on various specifications and details referred to throughout the master plan.

Figures



GSWC Engineering Planning October 2017

SECTION 2

Existing Water System Facilities

This section documents existing water system facilities for the Clearlake System. Detailed information about the major facilities, such as water supply facilities, storage facilities, pipelines, pumping facilities, and regulating valves serves as the basis for subsequent system analysis throughout the master plan. This section begins with an overview of the system, and then presents detailed information about these facilities.

2.1 Overview

The Clearlake System is located in Lake County, covers approximately 2.0 square miles, and serves a portion of the City of Clearlake and unincorporated Lake County.

The Clearlake System obtains its water supply from surface water provided by Clear Lake. The Clearlake system has an interconnection with Highlands Mutual Water Company (HMWC) for emergency use. The Clearlake system is not supplied by any wells.

Surface water from Clear Lake is pumped, through the Lakeshore Booster Station, to the Sonoma Water Treatment Plant. After treatment, water is supplied to the distribution system.

The Clearlake System has approximately 42 miles of pipelines that range in diameter from 1 inch to 12 inches.

2.2 Facility Descriptions

The major system facilities are shown in FIGURE 2-1 at the end of this Section. These facilities are discussed in detail in the following subsections:

- Pressure zones
- Supply sources
- Storage facilities
- Pumping stations
- Pressure regulating stations and flow control stations
- Transmission and distribution pipelines

2.2.1 Pressure and Distribution Zones

The Clearlake System is comprised of three pressure zones. TABLE 2-1 provides details of these pressure zones and lists the PRVs and/or booster stations that connect the zones. FIGURE 2-2 presents the system's hydraulic profile (schematic of the water system).

TABLE 2-1 Pressure Zone Details

Pressure Zone	HGL (ft msl)	Elevations Served (ft msl)	Supply and Storage Facilities*		
			Storage Tanks	Wells and Purchased Water	Booster Stations
Sampson Reservoir (Zone 1)[a]	1614	1330-1520	Sampson Reservoir and Sonoma WTP Clearwell	Highlands Mutual Water Company (HMWC) Interconnection	Finished Water Booster Station at Sonoma WTP and Manchester Booster at HMWC Interconnection
Oakcrest Reservoir (Zone 2)[a]	1614	1330-1520	Oakcrest Reservoir	-	San Joaquin Booster Station
Oakcrest Booster (Zone 3)	1706	1520-1614	-	-	Oakcrest Booster Station

* Does not include hydropneumatic tanks or emergency interconnections.

[a] The Sampson Reservoir Zone and the Oakcrest Reservoir Zone have the same HGL, due to the elevation of the Sampson and Oakcrest Reservoirs, respectively. The two zones are connected by the San Joaquin Booster Station, which during periods of high demand re-boosts Zone 1 water to compensate for headloss in the single 8-inch main along Lakeshore Drive and San Joaquin Ave.

2.2.2 Supply Sources

GSWC currently obtains its water supply for the Clearlake System from Clear Lake.

Surface Water

The Clearlake System is supplied by surface water from Clear Lake. The water is withdrawn from the lake via raw water boosters at the Lakeshore Plant, and is treated at the Sonoma Water Treatment Plant. The Treatment Plant processes are discussed in further detail in the Water Quality Evaluation section (Section 7) of this Master Plan. The Treatment Plant is not evaluated hydraulically in this Master Plan, but is included in the system-wide Supply and Storage Capacity Evaluation (Section 5) and the System Condition Assessment (Section 8).

Groundwater

The Clearlake System does not have any groundwater supply sources.

Active Wells

The Clearlake System does not have any wells.

TABLE 2-2 Active Wells

Well	Discharge Location	Wellhead Elevation (ft msl)	Pumping Water Level (ft)	Pumping Groundwater Elevation (ft msl)	TDH (ft)	Capacity (gpm)
-	-	-	-	-	-	-
Total groundwater production capacity						**0**

Non-operational Wells

The Clearlake System has no non-operational wells.

TABLE 2-3 Non-Operational Wells

Well	Discharge Location	Elevation (ft msl)	Previous Capacity (gpm)	Reason
-	-	-	-	-

Purchased Water

The Clearlake System does not have any purchased water supply connections.

TABLE 2-4 Imported Water Supply Connections

Imported Water Supply Connection	Hydraulic Grade Line (ft)	Capacity (gpm)	Pressure Setting at Connection* (psi)	Ground Surface Elevation (ft msl)	Imported Water Supply Pipelines
-	-	-	-	-	-

Emergency Interconnections

Water distribution systems are often connected to neighboring water systems to allow the sharing of supplies during short-term emergencies or during planned shutdowns of a primary supply source. The Clearlake System has one interconnection; this emergency interconnection is presented in TABLE 2-5.

TABLE 2-5 Emergency Interconnections

Interconnection Name/Location	Reliable Capacity* (gpm)	Notes
Manchester Ave., south of Austin Ave.	500	8-inch interconnection with Highlands Mutual Water Company

* Capacity of an emergency interconnection is not considered a reliable supply; rather, it is considered an “interruptible” supply, as it is based on whether or not the neighboring water agency has available water.

2.2.3 Storage Facilities

Water distribution systems rely on stored water to help equalize fluctuations between supply and demand, to supply sufficient water for firefighting, and to meet demands during an emergency or an unplanned outage of a major supply source. This section describes the existing storage facilities in the system.

Storage Tanks

The Clearlake System has two storage tanks and one clearwell. A summary of the reservoirs is provided in TABLE 2-6.

TABLE 2-6 Storage Tanks

Tank	Type and Zone	Bottom of Tank (ft msl)	High Water Elevation (ft msl)	Tank Height (ft)	Diameter (ft)	Volume (MG)
Sampson Reservoir	Ground level, gravity to Sampson Reservoir Zone	1578	1606	27	68	0.75
Oakcrest Reservoir	Ground level pumped to Oakcrest Booster Zone, gravity to Oakcrest Reservoir Zone	1577	1607	30	38	0.26
Sonoma WTP Clearwell[a]	Ground level pumped to Sampson Reservoir Zone	1417	1433	16	45	0.09[a]
Total systemwide storage capacity						**1.10**

[a] The Sonoma WTP Clearwell provides 0.21 MG of storage. However, 0.12 MG is dedicated to contact time (CT) requirements, thus only 0.09 MG is allocated as distribution system storage capacity. This capacity must be boosted into the distribution system, and therefore is not available under “emergency” conditions.

2.2.4 Pumping Stations

Pumping stations are required to convey water from ground-level tanks into the distribution system or from lower-pressure zones into higher-pressure zones (usually called booster pumping stations). Pumping stations may consist of one or more individual pumps. Multiple pumps at each station, or multiple pumping stations that serve the same pressure zone, help to increase water system reliability by ensuring that water can still be delivered into that zone if one pump is out of service. Critical pumping stations may be equipped with emergency power supplies in case of failure of the primary power source.

The Clearlake system includes 14 booster pumps. The Lakeshore Booster Station houses three boosters that pump raw water from Clear Lake to the Sonoma WTP, with a propane generator that is sized to supply backup electrical power for up to two boosters running at the same time. There are a total of six boosters at the Sonoma WTP, three of which are settled water boosters and three of which pump finished water to the distribution system; a propane generator at the Sonoma WTP is sized to supply backup electrical power for up to two settled water boosters and two finished water boosters running at the same time. The San Joaquin Booster Station houses two boosters. The Oakcrest Plant has two boosters to supply the Oakcrest Booster zone, with a propane generator that is sized to supply backup electrical power for either booster (only one running at a time). The Manchester Booster Station houses one booster, supplied by the HMWC interconnection.

TABLE 2-7 presents data relevant to the water system analysis.

TABLE 2-7 Booster Pumps

Facility	Pressure Zone		Backup Power Available	Elevation (ft msl)	TDH[a] (ft)	Capacity[b] (gpm)
	Suction	Discharge				
San Joaquin A	Sampson Reservoir Zone	Oakcrest Reservoir Zone	-	1330	45	100
San Joaquin B	Sampson Reservoir Zone	Oakcrest Reservoir Zone	-	1330	45	100
Lakeshore A	Clear Lake	Sonoma WTP	Propane Generator[c]	1330	172	500
Lakeshore B	Clear Lake	Sonoma WTP	Propane Generator[c]	1330	172	500
Lakeshore C	Clear Lake	Sonoma WTP	Propane Generator[c]	1330	172	500
Manchester	HMWC	Sampson Reservoir Zone	-	1346	260	500
Oakcrest A	Oakcrest Reservoir	Oakcrest Booster Zone	Propane Generator[d]	1580	100	35
Oakcrest B	Oakcrest Reservoir	Oakcrest Booster Zone	Propane Generator[d]	1580	100	35
Sonoma WTP	Sed. Basin	Filters	Propane	1417	47	500

Settled Booster A			Generator[c]			
Sonoma WTP Settled Booster B	Sed. Basin	Filters	Propane Generator[c]	1417	47	500
Sonoma WTP Settled Booster C	Sed. Basin	Filters	Propane Generator[c]	1417	47	500
Sonoma WTP Finished Booster A	Clearwell	Sampson Reservoir Zone	Propane Generator[c]	1417	217	500
Sonoma WTP Finished Booster B	Clearwell	Sampson Reservoir Zone	Propane Generator[c]	1417	217	500
Sonoma WTP Finished Booster C	Clearwell	Sampson Reservoir Zone	Propane Generator[c]	1417	217	500

msl: above mean sea level

[a] TDH is based on pump design point data.
[b] Capacity is based on facility design capacity.
[c] Generator(s) sized to supply backup electrical power for up to two boosters at each location running at the same time.
[d] Generator sized to supply backup electrical power for either booster (only one running at a time).

2.2.5 Pressure Regulating and Flow Control Stations

Pressure regulating and flow control stations allow distribution systems to transfer water from higher pressure zones to lower pressure zones without exceeding the allowable pressures in the lower zones or completely depressurizing the higher zone. The water is transferred through a valve that reduces the pressure or controls the flow rate to a specified setting. Regulating valves can operate based on one or more controlling parameters. The operational controls important to this analysis include pressure reducing, pressure sustaining, pressure relief, and flow rate:

- **Pressure reducing valve:** modulates to maintain a preset minimum downstream pressure setting; if the downstream pressure drops, then the valve will open until the downstream pressure matches the pressure setting.
- **Pressure sustaining valve:** modulates to maintain a preset minimum upstream pressure setting; if the upstream pressure drops, then the valve will close until the upstream pressure matches the pressure setting.
- **Pressure relief valve:** opens when the upstream pressure exceeds a preset maximum pressure setting.
- **Flow control valve:** modulates to maintain a preset flow rate through the valve regardless of pressure.

There are no hydraulically-operated valves in the Clearlake System.

TABLE 2-8 Pressure Regulating and Flow Control Valves

Name/Location	Pressure Zone		Type	Dia. (in)	Setting (psi)	Maximum Capacity (gpm)
	Upstream	Downstream				
-	-	-	-	-	-	-

2.2.6 Transmission and Distribution Pipelines

The Clearlake System has a total of 42 miles of pipe ranging in diameter from 1 to 12 inches. TABLE 2-9 lists the estimated footage of pipelines by diameter and material.

TABLE 2-9 Pipes by Size and Material

Diameter (in)	Length of Pipe by Material (ft)				Total Length (ft)
	AC	DI	PVC	STL	
1	-	-	-	1,572	**1,572**
1.5	-	-	-	2.288	**2,288**
2	-	-	6,040	32,204	**38,244**
3	-	-	-	858	**858**
4	17,937	145	18,131	9,081	**45,293**
6	41,331	781	12,456	247	**54,814**
8	43,246	3,364	27,929	-	**74,540**
12	-	441	3,803	87	**4,331**
Totals (ft)	102,513	4,731	68,359	46,337	**221,940**
Totals (mi)	19.4	0.9	12.9	8.8	**42.0**
Percent (%)	46.2	2.1	30.8	20.9	**100**

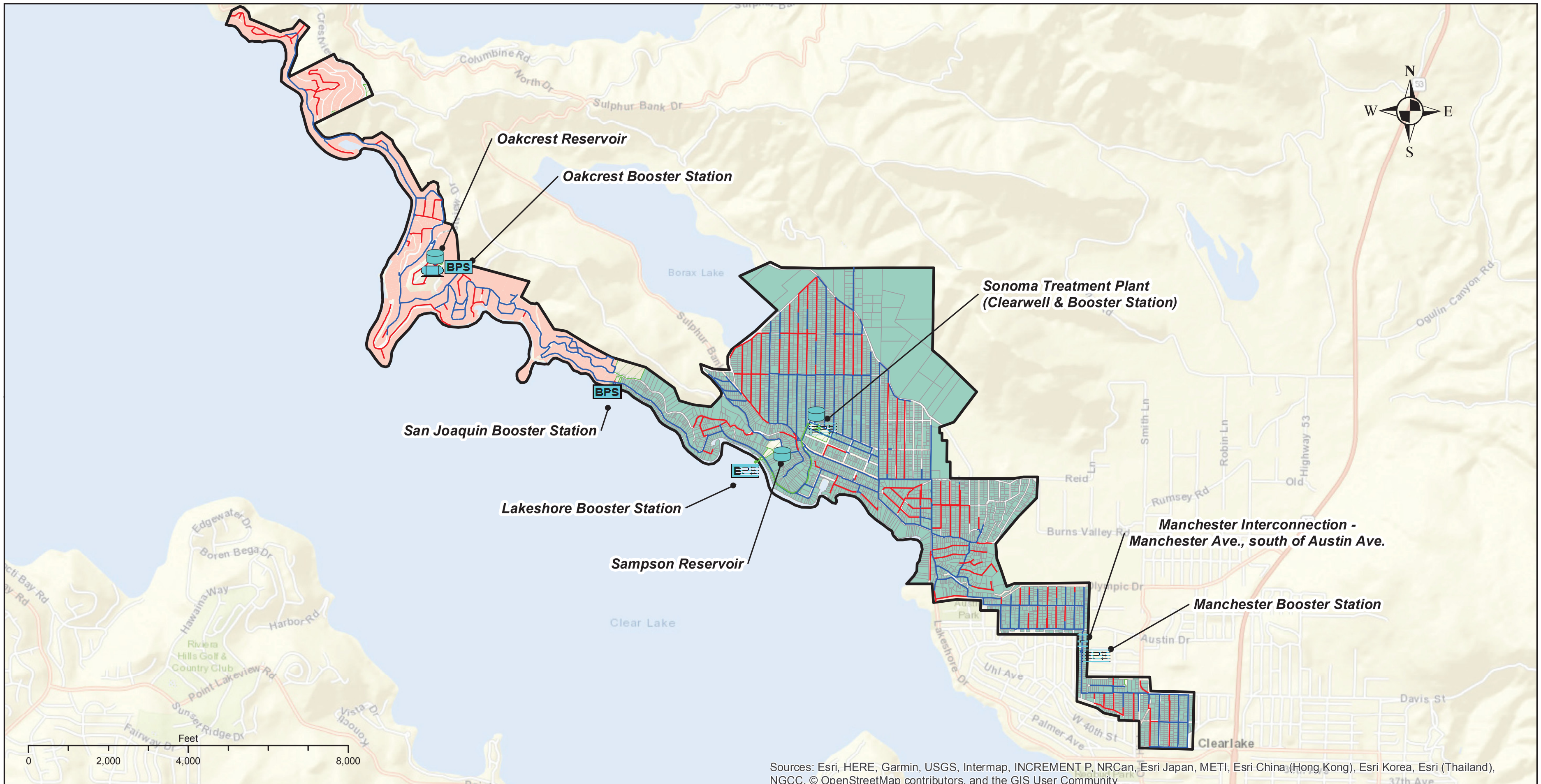
AC: asbestos cement or transite
DI: ductile iron
PVC: polyvinyl chloride
STL: steel

TABLE 2-10 lists the estimated footage of pipelines by diameter and year constructed.

TABLE 2-10 Pipes by Size and Year Built

Diameter (in)	Length of Pipe by Year Built (ft)			Total Length (ft)
	1960-1979	1980-1999	2000-2019	
1	1,455	-	116	**1,572**
1.5	2,288	-	-	**2,288**
2	32,121	5,162	962	**38,244**
3	626	-	232	**858**
4	27,742	17,546	6	**45,293**
6	33,346	20,694	774	**54,814**
8	24,103	35,077	15,360	**74,540**
12	87	4,244	-	**4,331**
Totals (ft)	121,767	82,722	17,451	**221,940**
Totals (mi)	23.1	15.7	3.3	**42.0**
Percent (%)	54.9	37.2	7.9	**100**

Figures



Existing Facilities

- BPS Booster Pump Station
- Reservoir
- Hydropneumatic Tank
- E Emergency Interconnection

Pipelines

- Less than 6"
- 6" or 8"
- 10" or Greater

Pressure Zones

- Oakcrest Reservoir Zone
- Oakrest Booster Zone
- Sampson Reservoir Zone

Clearlake System Boundary

FIGURE 2-1
MAJOR SYSTEM FACILITIES
GSWC REGION I WATER MASTER PLAN
CLEARLAKE SYSTEM

Golden State Water Company
A Subsidiary of American States Water Company

Last Update: 3/1/2019

Clearlake System Schematic

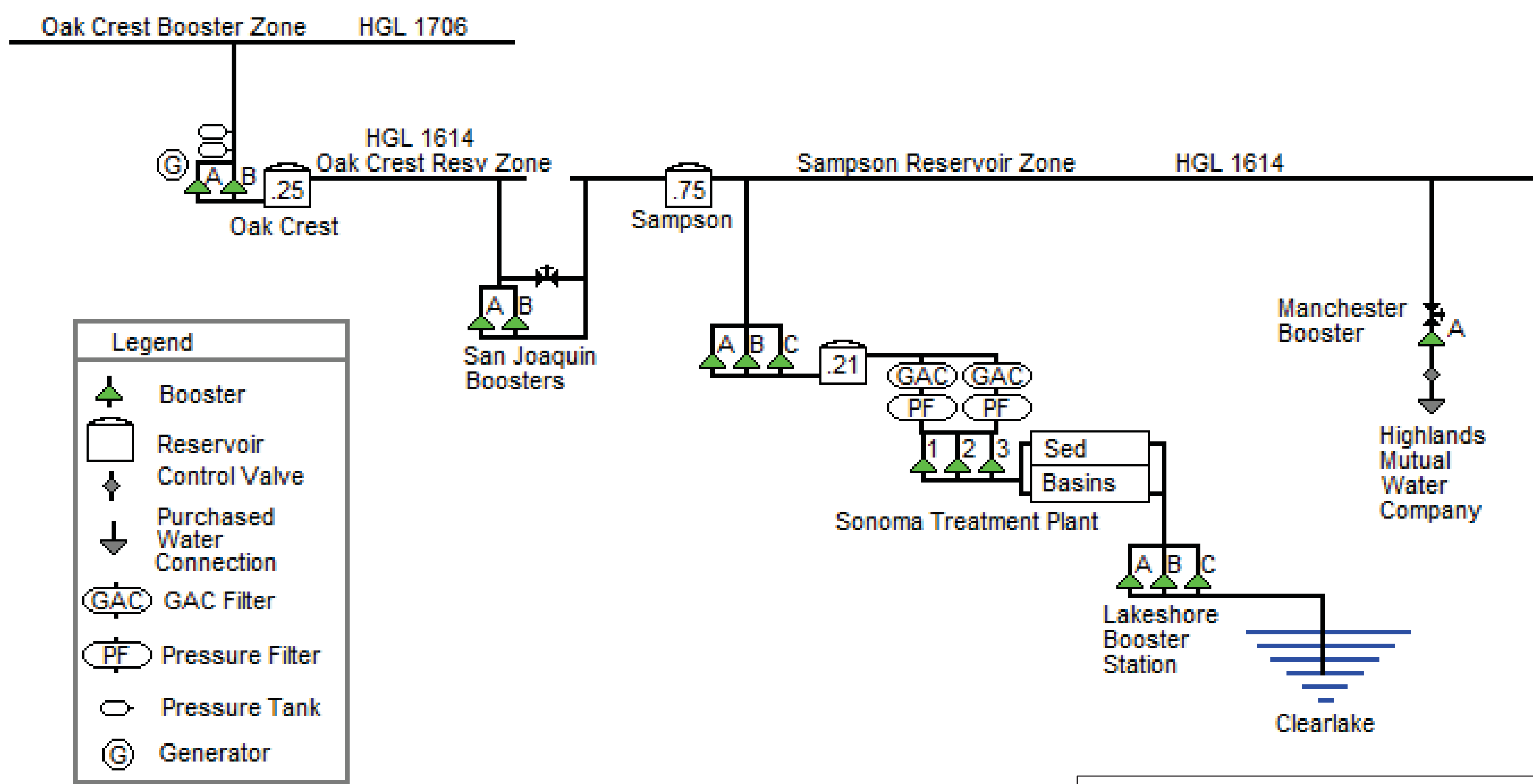


FIGURE 2-2
SYSTEM SCHEMATIC
GSWC REGION I MASTER PLAN
CLEARLAKE SYSTEM

Golden State
Water Company
A Subsidiary of American States Water Company

SECTION 3

Existing and Future Water Demands

This section documents existing and future water demands for the system and contains the following information:

- Demand definitions and scenarios
- Existing demands
- Peaking factors
- Future demand projections

3.1 Demand Definitions and Periods

Demand is classified in two basic ways:

- Demand: The total quantity of water required for a given period of time to meet the water system's various uses. These uses may include residential, commercial, industrial, and other revenue and non-revenue demands.
- Non-revenue water: The difference between the total amount of water produced from water supply sources and the total amount of water delivered to customers. This includes water used for firefighting, flushing, water lost due to system leaks and illegal connections. For systems without meters for all customers, this demand classification may not be quantifiable.

The water industry commonly uses several demand periods for developing water distribution system master plans. These demand periods are designated as average day demand (ADD), maximum day demand (MDD), peak hour demand (PHD), and maximum day demand plus fire flow (MDD+FF), and were applied as necessary to evaluate the system. The American Water Works Association (AWWA, 2005) defines these common steady-state demand periods as follows:

- ADD: Total amount of water delivered to the system in 1 year divided by 365 days.
- MDD: Maximum amount of water delivered to the system in any single day of the year.
- PHD: Amount of water required to meet peak demands during MDD. GSWC applies PHD for four hours when analyzing system supply and storage.
- MDD+FF: Amount of water required to fight a fire in addition to MDD.

3.2 Existing Demands

The existing demands represent a baseline for evaluating the existing system and to project future demands. The data used to develop the existing demands was based on historical water production data provided by GSWC.

3.2.1 Historical Water Use

For this master plan, it was assumed that the historical water production equaled the historical water demand (including non-revenue water). TABLE 3-1 summarizes historical annual water production from 2009 through 2018. The average water demand per connection for this period was 0.265 acre-feet per year per connection (AFY/conn.).

TABLE 3-1 Historical Annual Water Production

Year	Active Service Connections	Total Demand (AFY)*	Average Demand per Connection (AFY/conn.)
2009	2,156	539	0.250
2010	2,163	512	0.237
2011	2,159	546	0.253
2012	2,144	579	0.270
2013	2,134	606	0.284
2014	2,165	529	0.245
2015	2,168	526	0.242
2016	2,171	630	0.290
2017	2,078	619	0.298
2018	2,115	595	0.282
10-year average			**0.265**

* Includes non-revenue water use

FIGURE 3-1 summarizes the historical annual water production and number of active service connections. The figure demonstrates a correlation between the number of active service connections and the amount of water consumed. The average demand per connection varied between 0.237 and 0.298.

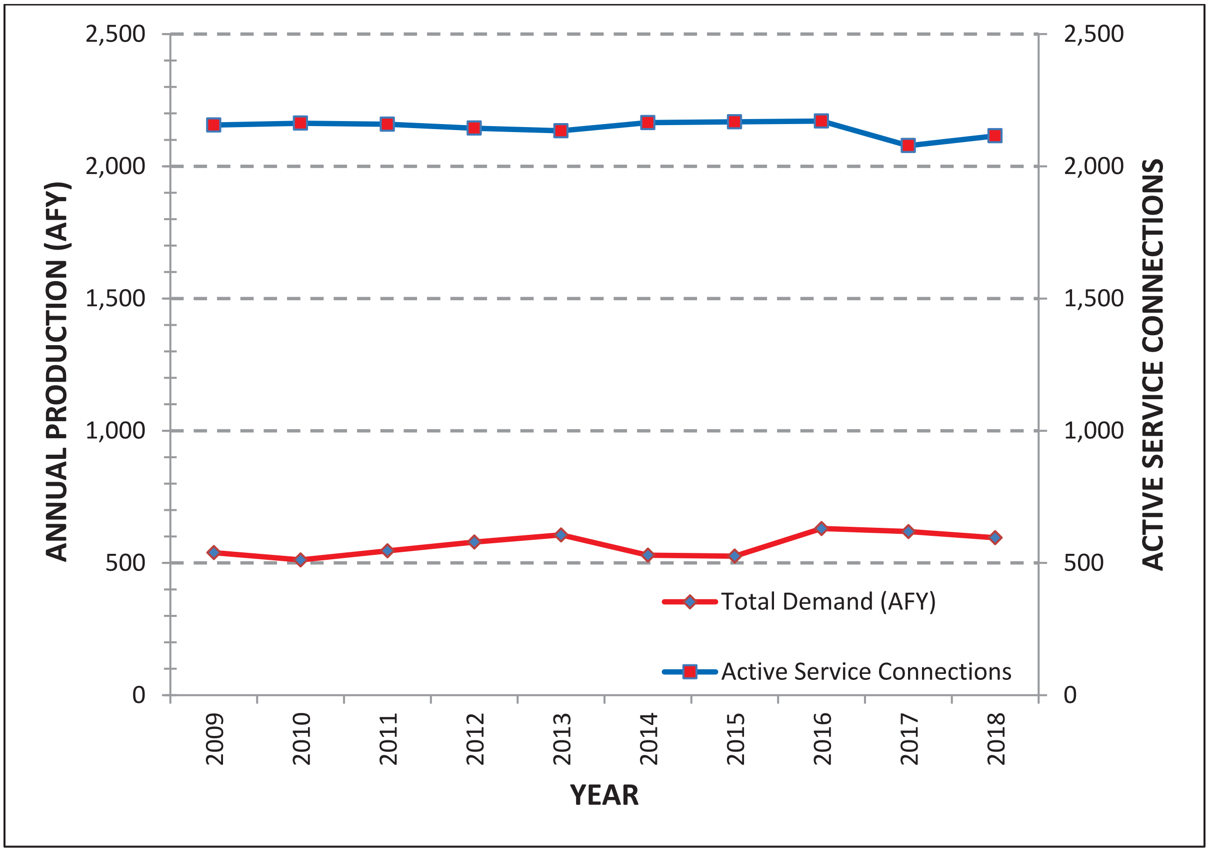


FIGURE 3-1 Historical Annual Production Totals and Active Service Connections for the Last 10 Years

3.2.2 Establishing Demands

The total water demand for existing conditions was estimated by multiplying the number of 2018 active service connections (2,115) with the 10-year average of the average demand per service connection (0.265 AFY/conn.), resulting in a system water demand of 561 AFY. Converting the system water demand to a daily demand produces an ADD of 347 gpm. This approach allows the calculation of ADD for various planning years, including the impact on anticipated growth, and then allows a direct calculation for other demand periods using the appropriate peaking factor.

To evaluate the system's performance during the MDD scenario, existing historical demand data were used in accordance with the Waterworks Standards set forth by the California Code of Regulations (2009). Section 64554.30 of the Waterworks Standards define MDD as "the amount of water utilized by customers during the highest day of use (midnight to midnight), excluding fire flow, as determined pursuant to Section 64554." Section 64554(b)(1) of the Waterworks Standards states "…identify the day with the highest usage during the past ten years to obtain MDD…". While GSWC is currently unable to track customer usage over an exact 24-hour period, GSWC does record daily water production – and, as stated in Master Plan Section 3.2.1, above, it can be "assumed that the historical water production equal[s] the historical water demand". However, because the daily production reads are not taken at midnight or always collected at the same time each day, the resulting data may be for time periods that can range anywhere from 16 to 32 hours (depending on the time of day the production data are collected). For example, the readings may be taken at 9am one day and 4pm the next; this introduces the chance of a fairly large error if only the recording for a single day is used, as it could include water production over a period longer than 24 hours. To address the possible variations in the hours per day within a given production read, GSWC identifies and uses the average of the three consecutive days with the highest production for each calendar year. By utilizing the average of these highest three consecutive days of water production, the resulting number is normalized, reducing the effect of any imprecision due to the time of day when the data was collected.

Table 3-2 presents the ADD, MDD, and peaking factor data over the last ten years.

TABLE 3-2 Historical Average and Maximum Day Demand

Year	ADD[a] AFY	ADD[a] gpm	MDD[b] (gpm)	MDD Peaking Factor (MDD:ADD)
2009	539	334	564	1.69
2010	512	317	507	1.60
2011	546	338	583	1.72
2012	579	359	584	1.63
2013	606	376	615	1.64
2014	529	328	519	1.58
2015	526	326	498	1.53
2016	630	391	559	1.43
2017	619	384	586	1.53
2018	595	369	549	1.49

[a] Includes non-revenue water use
[b] Average of three consecutive highest days

Peaking factors are typically calculated as a ratio of the demand period to ADD. For example, to determine the MDD peaking factor you would divide the MDD by the ADD. Peaking factors are used to estimate future water demands as presented and discussed in Section 3.3. To determine the existing MDD, the Waterworks Standards state the following in Section 64554(b):

> *A system shall estimate MDD and PHD for the water system as a whole (total source capacity and number of service connections) and for each pressure zone within the system (total water supply available from the water sources and interzonal transfers directly supplying the zone and number of service connections within the zone), as follows:*

(1) *If daily water usage data are available, identify the day with the highest usage during the past ten years to obtain MDD; determine the average hourly flow during MDD and multiply by a peaking factor of at least 1.5 to obtain PHD.*

According to TABLE 3-2, the highest MDD during the past ten years was 615 gpm, which occurred in 2013. Multiplying the MDD by a peaking factor of 1.5 results in a PHD of 923 gpm. It has been GSWC's experience that utilizing a peaking factor of 1.5 has been sufficient to meet PHD. Projected system demands for the ADD, MDD, and PHD scenarios are summarized in TABLE 3-3.

TABLE 3-3 Projected System Demands by Demand Period

Demand Period	GPM
ADD	347
MDD	615
PHD	923

3.3 Future Demand Projections

Future demands were projected first to estimate future ADD, and then peaking factors were applied to estimate MDD and PHD. The following sources of data and approaches were used:

- Growth-rate projections
- Water-demand projections

3.3.1 Growth Rate Projections

Growth rate projections were evaluated against equivalent estimates in the previous Clearlake System Water Master Plan and year 2010 U.S. census data to correlate population growth with the increase in service connections. This correlation was then used to determine future water demand.

3.3.2 Water Demand Projections

The projected annual water demands were extrapolated to year 2040 to determine the projected water use. Due to low growth projections in the Clearlake area and customer awareness of conservation needs, no rate of growth in annual water demands is anticipated.

FIGURE 3-2 presents the historical and projected annual water demands, including the most recent 10-year period. Projections of future demands are equal to the existing demand (2019) of 561 AFY.

The State of California is in a long term drought and the Governor has issued Executive Orders that will likely result in significant reductions in future demands. This Master Plan utilizes the current requirements established by the State of California and California Public Utilities Commission in evaluating needed facilities but acknowledges that the requirements may change. Subsequent updates to this Master Plan will reflect future changes in requirements.

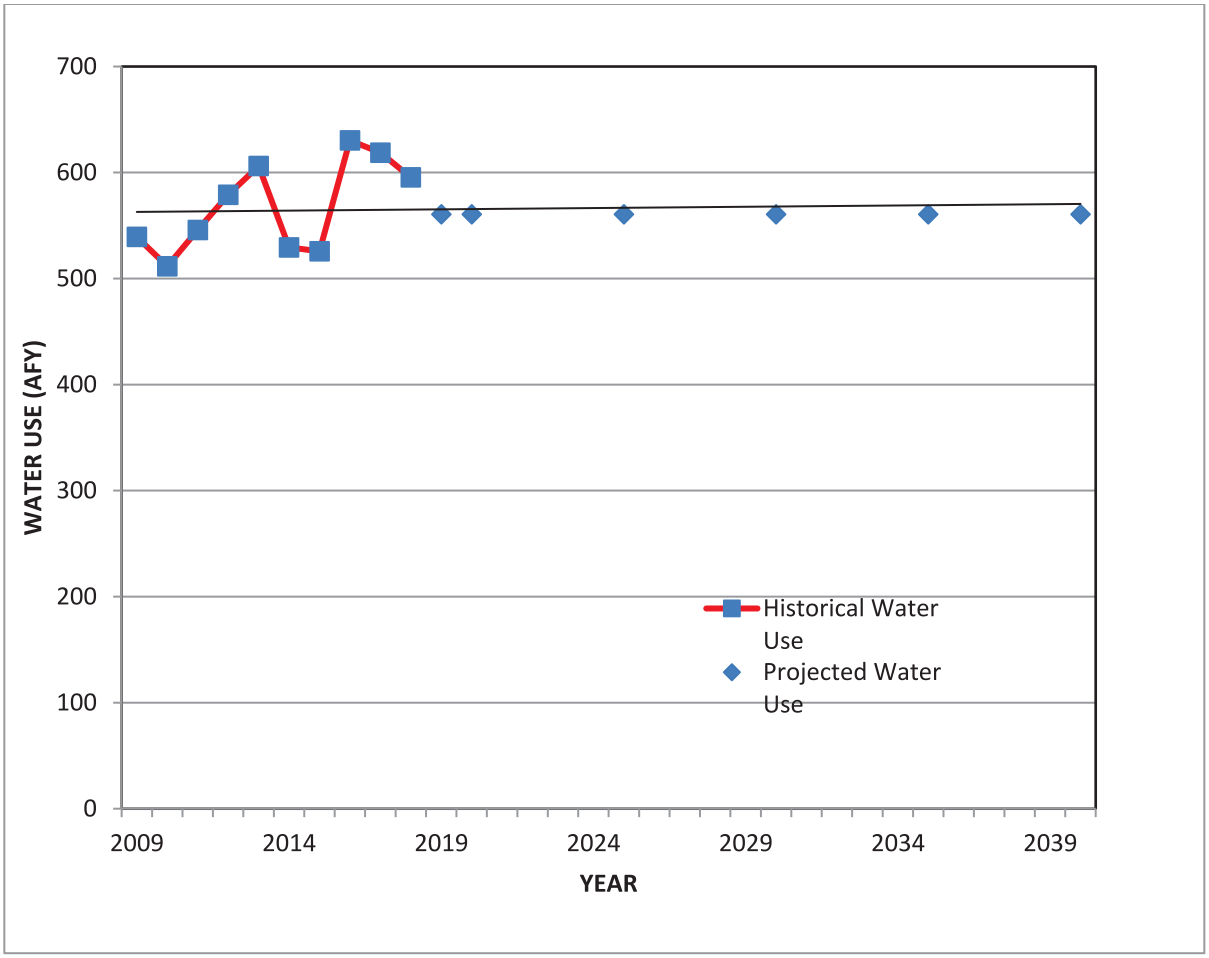


FIGURE 3-2 Historical Water Demand and Future Water Demand Projections

The water demands for 2040 project to be 561 AFY, resulting in an ADD of 350 gpm. To determine the projected MDD for year 2040, a peaking factor from TABLE 3-2 was applied to the projected ADD. The peaking factor associated with the highest MDD during the past ten years, 1.64 in 2013, was selected, resulting in a MDD of 574 gpm. A peaking factor of 1.5 was multiplied by the projected MDD to determine the projected PHD, which is 861 gpm. TABLE 3-4 summarizes the projected demands for ADD, MDD, and PHD periods.

TABLE 3-4 Water System Demands by Demand Period

	Demand Period and Peaking Factor			
Planning Year	**Annual Average (AFY)**	**ADD (gpm)**	**MDD (gpm)**	**PHD (gpm)**
2019	561	347	615	923
2040	561	350	574	861

SECTION 4

Hydraulic Model Development and Calibration

4.1 Overview

A computerized hydraulic model of a water distribution system is an important tool used as part of the Water Master Plan to conduct hydraulic analyses of the water system.

The computer model is used to analyze the facilities, operational characteristics, and water supply and consumption data of a water system. The water distribution system hydraulic model includes pipes, junction nodes (connection points for pipes and location of demands), valves, wells, pumps, purchased water connections, tanks, and reservoirs. Operational characteristics include parameters that control the method by which the water is distributed through the system, such as on and off settings for pumps, pressure or flow controls for hydraulically actuated valves, or main line valve closures. Data for supply and consumption determine where the water supply and demands are applied within the modeled distribution system.

Accurate computer model development begins with entering the correct information into the data file and calibrating the model to match existing conditions in the field. Once this foundation is complete, the resulting model becomes an invaluable tool. It can simulate the existing and future water system, identify system deficiencies, analyze impacts from increased demands, and determine the effectiveness of proposed improvements.

4.2 Construction and Calibration of the Hydraulic Computer Model

The Clearlake System hydraulic computer model was revised as part of the 2016 Master Plan. For this Master Plan, the model was checked for accuracy and updated to include newly constructed facilities. Valve settings for pressure regulating valves were also verified, and the system demands were validated. Localized calibration was performed to refine the model in certain sections of the system.

4.3 Summary

This Master Plan update included verification of the physical components represented in the hydraulic model, validation of demands in the model, and localized field testing and calibration.

It is important to note that model calibration for any water system is an ongoing effort. As changes in the system occur from changing demands, new infrastructure development, or changing operational settings, the model must be periodically updated and checked to ensure agreement with field measurements. This update serves as a baseline for future calibration efforts by GSWC.

SECTION 5

Supply and Storage Capacity Evaluation

This section documents the evaluation of the water supply and storage capacity for the Clearlake System. The evaluation results accomplished the following:

- Established storage needs for each pressure zone and the entire distribution system
- Identified supply and/or storage deficiencies in the existing and future systems
- Proposed improvements that mitigate the deficiencies identified

In each subsection, the supply and storage capacity of the existing and future water systems were measured against the objectives identified in the technical memorandum titled *Master Planning Criteria and Standards* (see Appendices). When the analysis indicated that the system did not meet these criteria, a deficiency was identified and facilities were proposed to mitigate the deficiency.

5.1 Overview

To provide a reliable water supply, a water system must be able to meet the system demands under a variety of conditions. The water supplied may be provided by a combination of supply sources, or stored water, or both. The specific demand period being analyzed may limit the source of water for the scenario. For example, stored water should not be used to meet ADD or MDD but could be used for PHD or MDD+FF. Therefore, each demand period may require a different ratio of water supplies and storage. This analysis examines various demand periods to determine if the system has the ability to reliably meet the system demands under typical demand scenarios using a combination of water supply sources and storage.

5.2 Evaluation Approach

This supply and storage capacity analysis examined the Clearlake System under two planning periods:

- **Existing (2019) system.** The demands for the existing water system were determined by multiplying the 10 year historical average demand per connection and the most recent number of connections (year 2018) to obtain the total system demand. The analyses assumed all facilities that were operational in 2019.

- **2040 system.** The long-term planning horizon (2040) water system analysis assumed 2040 demands (assumed buildout) and facilities included in the existing system analysis plus facilities needed to correct deficiencies in 2040.

5.2.1 Analysis Criteria

The Clearlake System must be capable of providing sufficient water supply and storage capacity to meet the minimum criteria summarized in TABLE 5-1. These criteria were extracted from the technical memorandum titled *Master Planning Criteria and Standards*.

The criteria apply to the system as a whole and to each pressure zone in the system. For planning purposes, this Master Plan utilizes the Planning Scenario 'MDD + Fire Flow' to analyze the system performance under a worst-case planning scenario. The worst-case planning scenario is represented by applying the single most stringent fire flow requirement established (based on land use plans or as designated by the local fire jurisdiction) for a structure within a hydraulic zone or planning area as the baseline fire flow requirement for the entire hydraulic zone or planning area. For the purposes of the planning analysis, this is considered a goal rather than a requirement. If the result of the worst case planning scenario indicates a deficiency in MDD + Fire Flow, it should be noted that there may not be a deficiency in the actual fire flow requirement for a particular structure, but rather that GSWC is not meeting the planning goal for the overall hydraulic zone or planning area.

TABLE 5-1 Supply and Storage Capacity Analysis Criteria

Planning Scenario	Demand and Duration	Evaluation Criterion	Storage Usage	Facilities Assumed to be Out of Service
Average day	ADD for 24 hours	Total capacity	No storage drawdown	-
Maximum day	MDD for 24 hours	Firm capacity	No storage drawdown	Largest pumping unit in system
Peak hour	PHD for 4 hours[1]	Firm capacity	Operational storage	Largest pumping unit in system
MDD + fire flow	MDD plus fire flow, duration varies[2]	Total capacity	Fire storage	-

[1] Operational storage required to meet peak demands during MDD was defined as the supply needs during 4 hours of PHD.
[2] Fire flow scenarios are based on fire agency maximum flow requirements for a single structure within a planning area and are applied throughout the planning area as part of the planning analysis. Actual fire flows may be less than the maximum fire flow used for planning analysis.

It is worth noting that the California Public Utilities Commission (CPUC) and State Water Resources Control Board, Division of Drinking Water (DDW) currently provide no specific requirements for storage volume. Therefore, recommended standards published by the American Water Works Association (AWWA) were considered in the development of the storage criteria used in this master plan.

5.2.2 Storage

In addition to providing adequate water supplies for the water consumers, water distribution systems often rely on stored water within the distribution system to provide the following operational benefits:

- Help equalize fluctuations between supply and demand.
- Supply sufficient water for firefighting.
- Meet demands during an emergency or unplanned outage of a major supply source.

AWWA defines three types of storage: operational, fire, and emergency. The amount of storage required for each of these types varies by system. Nevertheless, all three types of storage must be considered. In some cases, water stored in the groundwater basin can provide some of this storage. However, when the stored water does not flow by gravity and requires pumping, sufficient pumping redundancy and stand-by power generators must be provided if the storage source is to be considered reliable.

This analysis evaluates the ability of the system's storage facilities to meet the water system's storage requirements. The resulting volume must be allocated to the pressure zones where the demands exist, or to a neighboring zone (if there are pressure-regulating stations or check valves available that allow the water to flow into the neighboring zone). The water system must also be evaluated to determine if existing booster stations provide sufficient water to be pumped into the higher-pressure zones.

TABLE 5-2 presents the recommended operational, fire, and emergency storage criteria as defined by GSWC for the Clearlake System.

TABLE 5-2 Criteria for Calculating Storage

Storage Category	GSWC Criteria
Operational	Storage volume to meet PHD in addition to MDD supply
Fire	Maximum recommended fire storage volume in the system
Emergency	ADD for 12 hours

Operational Storage

The required volume of water for operational storage is determined by the volume needed for regulating the difference between the rate of supply and the daily variations (peaks) in water usage. This difference results in the lowest and highest operating levels in the reservoirs under normal conditions. The resulting volume must be allocated to either the pressure zone (where the demands exist) or to a higher-pressure zone (for use by the lower-pressure zone).

Fire Storage

The volume of water required for firefighting is a function of the instantaneous flow rate required to fight the fire over the duration of the fire flow event as determined by the local fire jurisdiction. Consideration is also made to evaluate the number of fire flow events that may occur before the volume can be replenished. Further, the volume of water necessary to fight a fire can be provided from water supply, water storage, or a combination thereof. For planning purposes, it is desirable and conservative to design the water system to have capacity within water tanks for the volume of water needed for firefighting; however, the fire storage in the tanks plus available supply in excess of MDD can be utilized to meet firefighting requirements. The fire-flow requirements listed in TABLE 5-3 were used to establish the flow rate and duration for each pressure zone; these criteria were used to identify the largest volume of water required for firefighting within each pressure zone (based on the land use in that zone and flow rates/durations provided by the Lake County Fire Protection District). The resulting fire-flow volumes are shown in TABLE 5-3.

TABLE 5-3 Fire Storage Volumes

Land Use Category	Minimum Fire Flow Required (gpm)	Duration (hr)	Recommended Fire Storage Volume (MG)
Residential/Light commercial	1,000	2	0.12
Large Residential (over 3,600 ft^2)	1,500	2	0.18
City Government (City Hall)	1,500	2	0.18

MG: million gallons

For the Clearlake System, it was assumed that only one fire event within the system would occur before storage tanks could recover. The lowest fire-flow volume (0.12 MG) is the result of a 1,000-gpm fire for duration of 2 hours (residential and light commercial use). The largest fire-flow volume (0.18 MG) is the result of a 1,500-gpm fire for a duration of 2 hours (City Hall in Zone 1, Large Residential in Zone 2).

Emergency Storage

Emergency storage is a dedicated source of water that can be used as a backup supply in the event a major supply source is interrupted. This can be provided by water from a second independent source, by water stored in reservoirs, or a combination of both. *Ten States Standards* recommends that emergency storage total between 12 and 24 hours of ADD volume. Because the Clearlake System contains multiple supply sources and a storage reservoir, 12 hours of ADD volume for this system is appropriate.

5.3 Existing System Evaluation

Evaluation of the existing system's supply and storage capacity involved analysis of key system facilities to identify supply or storage capacity deficiencies. This approach involved analyzing multiple proposed improvement alternatives to address these deficiencies. These proposed improvements were then evaluated to determine the most cost-effective alternatives, which would then be identified as the recommended improvements and incorporated into the CIP. The following subsections describe the existing system evaluation:

- Water demands for each demand period
- Supply facilities
- Storage facilities
- Capacity analysis
- Proposed improvements to address deficiencies in the existing system

5.3.1 Existing System Water Demands for Each Demand Period

TABLE 5-4 defines the existing demands by pressure zone for each demand period, based on the spatial demand allocation from the Clearlake GIS.

TABLE 5-4 Existing System Water Demands

Pressure Zone	ADD (gpm)	MDD (gpm)	PHD (gpm)	Demand by Zone (%)
Oakcrest Booster Zone	4	7	11	1
Oakcrest Reservoir Zone	41	72	108	12
Sampson Reservoir Zone	303	536	804	87
Total	**347**	**615**	**923**	**100**

5.3.2 Existing System Supply Facilities

The existing water supply facilities in the Clearlake System were identified in Section 2, Existing Water System Facilities. TABLE 5-5 summarizes the design production capacity of each supply source and systemwide totals for total capacity and firm capacity.

TABLE 5-5 Existing System Supply Facilities

Facility Name	Source	Pressure Zone	Total Capacity (gpm)
Sonoma WTP	Clear Lake/ Sonoma WTP Clearwell	Sampson Reservoir Zone	1,500
Manchester[a]	HMWC	Sampson Reservoir Zone	500
Main Zone total			**1,500**
Systemwide total			**1,500**

[a] This supply source was assumed to be unavailable for firm capacity. The HMWC interconnection is used during emergencies only.

5.3.3 Existing System Storage Facilities

The existing storage facilities in the Clearlake System are described in Section 2, Existing Water System Facilities. TABLE 5-6 summarizes the storage facilities for the Clearlake System.

TABLE 5-6 Existing System Storage Facilities

Facility Name	Primary Pressure Zone Served	Total Capacity (MG)
Sampson Reservoir	Sampson Reservoir Zone	0.75
Oakcrest Reservoir	Oakcrest Reservoir Zone	0.26
Sonoma WTP Clearwell[a]	Sampson Reservoir Zone	0.09[a]
Total storage capacity		**1.10**

[a] The Sonoma WTP Clearwell provides 0.21 MG of storage. However, 0.12 MG is dedicated to contact time (CT) requirements, thus only 0.09 MG is allocated as distribution system storage capacity. This capacity must be boosted into the distribution system, and therefore is not available under “emergency” conditions.

5.3.4 Existing System Supply and Capacity Analysis

This analysis of the existing water distribution system evaluated the two pressure zones separately and then the system as a whole to verify that adequate supply and storage facilities were available. The analysis reviewed the demand periods (ADD, MDD, PHD, MDD+FF and both planned and unplanned MWD outages); the duration for each demand period is detailed in TABLE 5-1. The duration of MDD+FF was established by the fire-flow criteria identified in TABLE 5-3.

In the following subsections, an analysis is performed for each pressure zone and for the overall system. The demands and production capacities for each zone are presented in a table that summarizes the results. These tables present the demands for each demand period in the zone and for any zones that depend on this zone for supplies. These demands are presented as a flow rate and are converted into a demand volume using the duration for the demand period. For example, a demand of 100 gpm for ADD would be equal to a demand volume of 144,000 gallons, given that the duration of ADD is 24 hours.

Available supplies are presented below the demand volume totals. Available supplies include water supply sources, booster pumping capacity, and stored water. Stored water was not used to provide water supplies during ADD or MDD. Stored water that was allocated as operational storage was assumed to be available for PHD, and water stored for fire flows was assumed to be available for MDD+FF. The total supplies were assumed to be available for ADD and MDD+FF. For the purpose of assuring reliable water service is provided to customers, each zone's ability to meet MDD and PHD with firm capacity was analyzed. (Firm capacity was defined as the available capacity with the largest pumping unit out of service.) The available production was calculated by converting flow rates into a production volume (using the duration of the demand period) and adding the available storage volume.

The last two lines of the table compare the system's available production capacity to the demands for the same duration. Where production capacity exceeds demands, the row *supply minus demand* will be positive. This indicates an adequate combination of supplies and storage. Where this occurs, the last row of the table, *supply meets demand*, will contain *yes*. However, if demands exceed production, then the row *supply minus demand* will have a negative value, and the row *supply meets demand* will contain *no*. In this latter case, proposed improvements were evaluated to correct the deficiency.

Sampson Reservoir Zone Analysis

Water supply to the Sampson Reservoir Zone is provided by three boosters from the Sonoma WTP Clearwell, as listed in TABLE 2-7. There is 0.75 MG storage in this pressure zone from the Sampson reservoir. Fire flow was assumed to occur at only one place at a given time, and the maximum fire flow (0.18 MG) was assumed.

The overall capacity analysis for the Sampson Reservoir Zone is presented in TABLE 5-7.

TABLE 5-7 Existing System Supply and Capacity Analysis—Sampson Reservoir Zone

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Sampson Res Zone		303	0.436	536	0.772	804	0.193	2,036	0.244
Oakcrest Res Zone	BP	45	0.065	79	0.114	100	0.024	79	0.009
Total Demand		**348**	**0.501**	**615**	**0.886**	**904**	**0.217**	**2,115**	**0.254**
Supply	Capacity								
HMWC	500	0	0.000	0	0.000	0	0.000	0	0.000
Boosters	1,500	348	0.501	615	0.886	904	0.217	615	0.074
Reservoirs	0.75	-	-	-	-	0	0.000	1,500	0.180
Total Supply		**348**	**0.501**	**615**	**0.886**	**904**	**0.217**	**2,115**	**0.254**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios.

Oakcrest Reservoir Zone Analysis

Water supply to the Oakcrest Reservoir Zone is provided by two boosters from the Sampson Reservoir Zone, as listed in TABLE 2-7. There is 0.26 MG storage in this pressure zone from the Oakcrest reservoir. Fire flow was assumed to occur at only one place at a given time, and the minimum fire flow (0.12 MG) was assumed.

The overall capacity analysis for the Oakcrest Reservoir Zone is presented in TABLE 5-8.

TABLE 5-8 Existing System Supply and Capacity Analysis—Oakcrest Reservoir Zone

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Oakcrest Res Zone		41	0.059	72	0.104	108	0.026	1,072	0.129
Oakcrest Bstr Zone	BP	4	0.006	7	0.010	11	0.003	7	0.001
Total Demand		**45**	**0.065**	**79**	**0.114**	**119**	**0.029**	**1,079**	**0.129**
Supply	Capacity								
Boosters	200	45	0.065	79	0.114	100	0.024	200	0.024
Reservoirs	0.25	-	-	-	-	19	0.005	879	0.105
Total Supply		**45**	**0.065**	**79**	**0.114**	**119**	**0.029**	**1,079**	**0.129**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios.

Oakcrest Booster Zone Analysis

Water supply to the Oakcrest Booster Zone is provided by two boosters from the Oakcrest Tank, as listed in TABLE 2-7. There is no storage in this pressure zone. Fire flow was assumed to occur at only one place at a given time, and the minimum fire flow (0.12 MG) was assumed.

The overall capacity analysis for the Oakcrest Booster Zone is presented in TABLE 5-9.

TABLE 5-9 Existing System Supply and Capacity Analysis—Oakcrest Booster Zone

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Oakcrest Bstr Zone		4	0.006	7	0.010	11	0.003	1,007	0.121
Total Demand		**4**	**0.006**	**7**	**0.010**	**11**	**0.003**	**1,007**	**0.121**
Supply	Capacity								
Boosters	70	4	0.006	7	0.010	11	0.003	70	0.008
Total Supply		**4**	**0.006**	**7**	**0.010**	**11**	**0.003**	**70**	**0.008**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**-937**	**-0.112**
Supply Meets Demand		**YES**		**YES**		**YES**		**NO**	

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios. For the MDD+FF scenario, fire flow is supplied by a fire hydrant near the Oakcrest Reservoir in the Oakcrest Reservoir Zone; otherwise the Oakcrest Booster Zone would have a deficiency of 937 gpm (0.112 MG) for MDD+FF. A future project may be considered to upsize the Oakcrest Booster Station capacity, as the referenced fire hydrant in the Oakcrest Reservoir Zone – although near the Oakcrest Reservoir site – is a significant distance (more than 500 LF) from the majority of the parcels in the booster zone. Upsizing the booster capacity would also require upsizing the 4-inch Steel pipelines that currently serve the Oakcrest Booster Zone, and could be combined with a project identified later in this Master Plan (project 1.1.2, Table 6-3) to expand the Oakcrest Booster Zone to also include customer connections on Crestview Dr./San Joaquin Ave. that currently receive low pressure in the Oakcrest Reservoir Zone.

Systemwide Capacity Analysis

In the systemwide analysis, all supply and storage facilities were included. The total existing demands were presented in TABLE 5-4. The total and firm production capacities in TABLE 5-5 and the storage facilities in TABLE 5-6 were used for the appropriate demand periods. The fire flow used for MDD+FF was based on the largest fire flow in the system, a 1,500-gpm fire flow for 2-hour duration.

The results of the systemwide supply and storage analysis for the existing system are summarized in TABLE 5-10.

TABLE 5-10 Existing System Supply and Capacity Analysis—Systemwide

		Planning Scenario							
		ADD		**MDD**		**PHD**		**MDD+FF**	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Total Demand		**348**	**0.501**	**615**	**0.886**	**923**	**0.222**	**2,115**	**0.254**
Supply	Capacity								
HMWC	500	0	0.000	0	0.000	0	0.000	0	0.000
Boosters	1,500	348	0.501	615	0.886	904	0.217	615	0.074
Reservoirs	1.09	-	-	-	-	19	0.005	1,500	0.180
Total Supply		**348**	**0.501**	**615**	**0.886**	**923**	**0.222**	**2,115**	**0.254**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

The systemwide supply and storage analysis results for the existing system indicate that the existing supply meets the demands for all planning scenarios.

5.3.5 Existing System Storage Analysis

The analysis of the existing storage facilities evaluated the required storage for each pressure zone and compared it to the existing storage available for each zone to determine the storage deficiencies. The benefits of storage and the types of storage (operational, fire, and emergency) are described in more detail in section 5.2.2.

TABLE 5-11 evaluates the three types of storage to calculate the total required storage for each zone and the entire system. The operational storage is calculated by subtracting the MDD from the PHD to obtain the additional flowrate that is required during the PHD scenario. This additional flowrate is multiplied by the duration of PHD and then converted to a volume to determine the required operational storage. A duration of four hours was used to account for the typical duration of peak demands during the day. The fire storage for each zone is based on criteria given in section 5.2.2. In cases where two or more pressure zones retain their fire storage in the same reservoir, that reservoir only needs to contain the fire storage for the zone with the largest recommended fire storage volume. This is because the criteria consider only one fire flow can occur in the system at any given time. To prevent accounting for excess fire storage, pressure zones were given a fire storage total of 0 MG in TABLE 5-11 when fire storage of larger or equal size was used in another zone that retains its fire storage in the same tank. The emergency storage is the volumetric measurement of the ADD over a duration of 12 hours.

Storage deficiencies are identified for each zone in TABLE 5-12. All tanks in the existing system are listed in the left column of the table. All pressure zones in the existing system are listed in the top row of the table. The numbers in the table represent the allotted amount of storage, in millions of gallons, for each zone from each tank. A dash in the table denotes storage from that tank is unavailable for that zone. Zones that are able to utilize storage in a tank, but are not allotted any storage from it are shown in the table as zero. Summing the numbers across the rows results in the total storage volume of the tank listed in the left column of that row. Summing the numbers going down the columns results in the available storage for the zone listed in the top row of that column. The required storage, taken from

TABLE 5-11, is given in the row below the available storage. Subtracting the required storage from the available storage within a column results in the excess storage for that column's zone. Negative numbers imply a storage deficiency and are given a "NO" in the adequate storage column. A "YES" in the adequate storage column implies there is adequate storage available for that zone. Fire storage is calculated to supplement supply when the supply is less than the current demand plus fire flow (see Section 5.3.4). Fire storage requirements are planning standards and fire storage is typically only required in times of high demands, supply limitations, and/or emergencies.

TABLE 5-11 Existing System Storage Analysis - Calculated Storage

	Zones			
	Sampson Reservoir Zone	**Oakcrest Reservoir Zone**	**Oakcrest Booster Zone**	**Systemwide**
Operational				
PHD	804	108	11	923
MDD	536	72	7	615
PHD minus MDD	268	36	4	308
Duration	4	4	4	4
MG	0.064	0.009	0.001	0.074
Fire				
GPM	1500	1000	1000	-
Duration	2	2	2	-
MG*	0.180	0.120	0.000	0.300
Emergency				
ADD	303	41	4	347
Duration	12	12	12	12
MG	0.218	0.030	0.003	0.250
Total Recommended Storage	**0.462**	**0.158**	**0.004**	**0.624**

* A fire storage total of zero indicates that fire storage of larger or equal size was used in another zone that receives its fire storage from the same tank.

NOTE: All demand period scenarios (ADD, MDD, and PHD) are given in gallons per minute (GPM). All durations are given in hours. The rows titled "MG" and the total required storage are given in million gallons (MG)

TABLE 5-12 Existing System Storage Analysis - Adequacy Evaluation

	Zones			
	Sampson Reservoir Zone	**Oakcrest Reservoir Zone**	**Oakcrest Booster Zone**	Total
Sampson Reservoir	0.750	-	-	0.750
Oakcrest Reservoir	-	0.252	0.004	0.256
Sonoma WTP Clearwell	0.090	-	-	0.090
Available Storage	0.840	0.252	0.004	1.096
Recommended Storage*	0.462	0.158	0.004	0.624
Available Minus Recommended	0.378	0.094	0.000	0.472
Adequate Storage	**YES**	**YES**	**YES**	**YES**

* Recommended Storage numbers are from Table 5-10
NOTE: All numbers given are in million gallons (MG)

The existing system storage analysis results indicate no storage deficiency.

5.3.6 Proposed Improvements to Address Deficiencies in the Existing System

Various alternatives were considered while investigating improvements to correct the deficiencies identified in the supply and storage evaluation; these are listed in TABLE 5-13. Deficiencies may be corrected by adding supply, storage, or a combination of both. In these cases, the deficiency is shown in both supply (gpm) and storage (MG). The descriptions of the deficiency alternatives are given at the end of TABLE 5-13.

There were no deficiencies identified in the supply and storage evaluation.

The numbering system used in TABLE 5-13 is a series of three numbers. The first number indicates the planning period: 1 for the existing system and 2 for the 2040 system. The second number indicates the deficiency number, which starts at 1 and increments by 1 for each deficiency identified. The third number identifies the improvement alternative, but zero is reserved for the deficiency. Therefore, the alternative number 1.2.3 would be used to identify the third proposed alternative for the second deficiency in the existing system.

TABLE 5-13 Existing System Proposed Supply and Storage Improvements

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
-	-	-	-	-

5.3.7 Recommended Improvements to Address Deficiencies in the Existing System

No deficiencies were identified in the Clearlake System.

TABLE 5-14 Existing System Recommended Supply and Storage Improvements

Alternative Number	Alternative Description	Deficiencies Resolved	Supply/Storage Capacity
-	-	-	-

5.4 2040 System Evaluation

Analysis of the water system for the year 2040 was performed to identify long-term improvements needed for the water system at buildout. This analysis included the following assumptions:

- Existing supply sources would remain active or be replaced in kind.
- Planned improvements to address existing system deficiencies plus the post-2016 improvements are operational.
- The demands developed in Section 3, Existing and Future Water Demands, were assumed for the respective demand periods.

5.4.1 2040 System Water Demands for Each Demand Period

TABLE 5-15 defines the 2040 demands for the Clearlake System. The demands are not provided for each pressure zone because it is unknown how much each zone's demands will increase by the year 2040.

TABLE 5-15 2040 System Water Demands

	ADD (gpm)	MDD (gpm)	PHD (gpm)
Systemwide	350	574	861

5.4.2 2040 System Supply Facilities

The supply facilities for the 2040 system include all supply facilities in the existing system along with all recommended supply facilities to resolve the existing system's deficiencies. TABLE 5-16 summarizes the supply for the 2040 System.

TABLE 5-16 2040 System Assumed Supply Facilities

Facility Name	Total Capacity (gpm)
Additional facilities in the 2040 System	0
Existing supply – Sonoma WTP	1,500
Total production capacity for 2040	**1,500**

5.4.3 2040 System Storage Facilities

The storage facilities for the 2040 system include all storage facilities in the existing system along with all recommended storage facilities to resolve the existing system's deficiencies. TABLE 5-17 summarizes the storage for the 2040 System.

TABLE 5-17 2040 System Assumed Storage Facilities

Facility Name	Primary Pressure Zone Served	Total Capacity (MG)
Recommended storage facilities	-	0
Existing storage	Systemwide	1.10
Total storage capacity		**1.10**

5.4.4 2040 System Capacity Analysis

The supply analysis for the 2040 system uses the 2040 projected demands and includes the recommended 2040 supply improvements to analyze system deficiencies. An analysis is not given for each pressure zone because it is unknown how much each zone's demands will increase by year 2040. The supply analysis is given in TABLE 5-18.

TABLE 5-18 2040 System Supply and Capacity Analysis—Systemwide

		Planning Scenario							
		ADD		**MDD**		**PHD**		**MDD+FF**	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Total Demand		**350**	**0.504**	**574**	**0.827**	**861**	**0.207**	**2,074**	**0.249**
Supply	Capacity								
HMWC	500	0	0.000	0	0.000	0	0.000	0	0.000
Boosters	1,500	350	0.504	574	0.827	861	0.207	1,500	0.180
Reservoirs	1.09	-	-	-	-	0	0.000	574	0.069
Total Supply		**350**	**0.504**	**574**	**0.827**	**861**	**0.207**	**2,074**	**0.249**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

The systemwide supply and storage analysis results for the 2040 system indicate that the supply meets the demands for all planning scenarios.

5.4.5 2040 System Storage Analysis

The storage analysis for the 2040 system uses the 2040 projected demands and includes the recommended supply and storage improvements for the existing system to analyze system deficiencies. Like the 2040 supply analysis, each pressure zone is not analyzed because it is unknown how much each zone's demands will increase by year 2040. The storage analysis is given in TABLE 5-19.

TABLE 5-19 2040 System Storage Analysis

Scenario		Systemwide
Operational	PHD	861
	MDD	574
	PHD minus MDD	287
	Duration	4
	MG	0.069
Fire	GPM	1,500
	Duration	2
	MG*	0.180
Emergency	ADD	350
	Duration	12
	MG	0.252
Total Recommended Storage		0.501
Available Storage in 2040		1.100
Available minus Recommended		0.599
Adequate Storage		YES

5.4.6 Proposed Improvements to Address Deficiencies in the 2040 System

No deficiencies were identified for the 2040 system, as shown in TABLE 5-20.

TABLE 5-20 2040 System Proposed Supply and Storage Improvements

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
-	-	-	-	-

5.4.7 Recommended Improvements to Address Deficiencies in the 2040 System

No deficiencies were identified for the 2040 system, as shown in TABLE 5-21.

TABLE 5-21 2040 System Recommended Supply and Storage Improvements

Alternative Number	Alternative Description	Deficiencies Resolved	Supply/Storage Capacity
-	-	-	-

5.5 Summary of Proposed Supply and Storage Improvements through 2040

According to the supply and capacity analysis results in this Master Plan, the following additional supply is necessary to meet future demands:

- Existing system: no additional supply
- 2040 system: no additional supply

According to the storage analysis results in this Master Plan, the following additional storage is necessary to meet future demands:

- Existing system: no additional storage
- 2040 system: no additional storage

No storage or supply deficiencies were identified for the existing system or the 2040 system.

The supply and storage improvements planned by GSWC and analyzed in these evaluations are further examined in Section 6, Hydraulic Analysis and Evaluation. The hydraulic analysis helps determine the optimal configuration of improvements to provide maximum operational and cost benefit, and any resulting recommended improvements are incorporated into the CIP.

SECTION 6

Hydraulic Analysis and Evaluation

This section documents the hydraulic analysis and evaluation results for the Clearlake System. The hydraulic analysis used the calibrated computer model to evaluate the existing water system. This analysis and evaluation accomplished the following tasks:

- Summarized the criteria for the hydraulic analysis
- Performed simulations for various demand conditions and demand periods
- Analyzed the modeling results to identify deficiencies
- Analyzed various proposed improvements to investigate ways to mitigate these deficiencies
- Developed a list of recommended improvements that provide a cost-effective means to correct deficiencies

In following sections, the hydraulic analysis results of the existing water system were compared with the objectives identified in the technical memorandum titled *Master Planning Criteria and Standards* (see Appendices). When the analysis indicated that the system did not meet these criteria, a deficiency was identified and improvements were proposed to mitigate the deficiency.

6.1 Overview

Hydraulic analyses of networked water distribution systems are most efficiently performed with the aid of hydraulic computer models and specialized software that perform the numerical analysis. The hydraulic computer model assists with measuring system performance, analyzing operational improvements, and developing a systematic method of determining the size and timing required for new facilities. The model can be used to analyze existing water systems, future water systems, and the effect of specific improvements. By analyzing numerous planning scenarios relatively quickly and easily, the model provides answers to several "what if" questions. The computer program analyzes all of the information in the system data file and generates results in terms of pressures, flow rates, and operating status. The key to successfully using the computer model is correct interpretation of these results, and understanding how the water distribution system was affected.

6.2 Analysis Approach

This hydraulic analysis examined the Clearlake System for only one planning period:

- **Existing (2019) system.** The existing water system analyses assumed 2019 demands, as described in Section 3, and facilities that were operational in 2019.

The demands used in this hydraulic analysis are the same as used for the supply and storage capacity analysis in Section 5.

6.2.1 System Performance Criteria

Hydraulic analysis of the water system involved the use of a computer model that was developed specifically for the Clearlake System and calibrated to conditions observed in the field (see Section 4, Hydraulic Model Development and Calibration). This computer model was used to identify hydraulic deficiencies under the existing planning scenario. Hydraulic model simulations were developed to analyze demand periods (ADD, MDD, PHD, and MDD+FF) to determine whether the system could meet the performance objectives identified for this master plan. These criteria are summarized in TABLE 6-1.

TABLE 6-1 Hydraulic Analysis Criteria

Demand Period	Pipeline Criteria[a]	Pressure Criteria[b]
ADD	Velocity less than 5 fps and head loss less than 6 ft per 1,000 ft	Greater than 40 psi and less than 125 psi
MDD	Velocity less than 5 fps and head loss less than 6 ft per 1,000 ft	Greater than 40 psi and less than 125 psi
PHD	Velocity less than 10 fps	Greater than 30 psi and less than 125 psi
MDD + fire flow	Velocity less than 10 fps	Greater than 20 psi

[a] If velocity or headloss in a pipeline exceeded the criteria listed but did not result in low pressures in the system, the pipeline was not recommended for replacement due to hydraulic deficiencies alone.
[b] Pressure criteria apply only at service connections.

6.2.2 Fire-flow Requirements

In addition to providing adequate water supply and pressure to serve residential, commercial, and industrial water demands placed on the system, the water system must also deliver an adequate supply for firefighting. Since fires can occur at any time, the water system must be ready to provide the required flow at all times with an adequate residual pressure. The water system should be capable of providing the fire flows during an MDD period (MDD+FF), which represents the day of the year having the highest water demands.

To determine the system's capacity to provide adequate fire flows, it was necessary to establish minimum fire-flow demand requirements to be applied to various locations throughout the distribution system, as well as a minimum residual pressure (the pressure near the flowing hydrant) and system pressure. The local agency responsible for establishing fire-flow requirements for the Clearlake System service area is the Los Angeles County Fire Department. Their Fire Code Regulation #8, Fire Flow and Hydrant Requirements (dated 12/15/04), was used as a guide to develop the fire-flow criteria established for this master plan, which were presented in the previous section in TABLE 5-3.

6.3 Existing System Hydraulic Analysis

Several hydraulic computer model simulations were conducted for the existing distribution system to identify system and operational deficiencies, and to evaluate system improvements to mitigate these deficiencies. If more than one alternative was possible to mitigate a deficiency, the most cost-effective and constructible improvement was recommended.

6.3.1 Operational Assumptions

GSWC operations staff provided information on how the Clearlake System would normally be operated under ADD, MDD, and PHD periods. Based on this information, the facilities available for the hydraulic analysis of the existing system are presented in TABLE 6-2. (Note: The status of wells, MWD connections, booster pumps and storage tanks were not based on the model results, but on the amount of supply needed for each demand period. For ADD, there is flexibility to operate various combinations of wells, as not all of the wells need to be operational to achieve the desired pressures; for MDD and PHD scenarios, firm capacity must be used.)

TABLE 6-2 Existing System Operating Facility Status

Facility Name	ADD	MDD	PHD
Wells—Main Zone			
-	-	-	-
Booster pumps			
San Joaquin A	Available	On	On
San Joaquin B	Available	Off	Off
Lakeshore A	Available	Available	Available
Lakeshore B	Available	Available	Available
Lakeshore C	Available	Available	Available
Manchester	Available	Off	Off
Oakcrest A	Available	On	On
Oakcrest B	Available	On	On
Sonoma WTP Settled Booster A	Available	Available	Available
Sonoma WTP Settled Booster B	Available	Available	Available
Sonoma WTP Settled Booster C	Available	Available	Available
Sonoma WTP Finished Booster A	Available	On	On
Sonoma WTP Finished Booster B	Available	Off	On
Sonoma WTP Finished Booster C	Available	Off	Off
Storage tanks			
Sampson Reservoir	75%	75%	75%
Oakcrest Reservoir	75%	75%	75%
Sonoma WTP Clearwell	75%	75%	75%

6.3.2 Average Day Scenario Analysis

To analyze the average day scenario for the existing system, simulations were performed using the computer model with ADD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 347 gpm. Only the facilities listed as 'Available' in TABLE 6-2 were used for ADD. (Note: Storage should not be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.3 Maximum Day Scenario Analysis

To analyze the maximum day scenario for the existing system, simulations were performed using the computer model with MDD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 615 gpm. Only the facilities listed as 'On' in TABLE 6-2 were used for MDD. (Note: Storage should not be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.4 Peak Hour Scenario Analysis

To analyze the peak hour scenario for the existing system, simulations were performed using the computer model with PHD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 923 gpm. Only the facilities listed as 'On' in TABLE 6-2 were used for PHD. (Note: Storage may be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.5 Fire-flow Scenario Analysis

For this master plan revision, the fire flow scenario was not analyzed.

6.3.6 Analysis Results and Recommended Improvements for the Existing System

Various alternatives were considered to correct the hydraulic deficiencies identified in the hydraulic analysis. The proposed improvements were evaluated for their ability to correct the deficiency and for their cost-effectiveness as compared to other alternatives.

Steady-State Deficiencies

The deficiencies identified in the ADD, MDD, and PHD simulations for the existing system are presented in

TABLE 6-3 (Note: This table also includes any existing system improvements for supply and storage from Section 5). These deficiencies were analyzed in detail using the computer model by adding proposed improvements, reviewing the updated results, and repeating this process until acceptable results were obtained.

The distribution system was analyzed to identify areas of the system that experienced pressures below 40 psi or above 125 psi (criteria identified in TABLE 6-1). Various steady-state planning scenarios were used to analyze system pressures under different demand conditions to verify adequate system pressures. Where low pressures were observed during the analysis, one or more approaches were used to mitigate the low-pressure problem. In some cases, low pressures can be corrected with no physical improvement, such as by increasing the pressure setting of an upstream pressure regulating valve. However, sometimes substantial improvements may be required. Improvements may include replacing older pipelines with larger diameter pipelines to reduce friction losses, constructing new pump stations or pressure regulating stations, or modifying the boundaries of an existing pressure zone.

High velocities in water pipelines can also be an indication of an operational deficiency, and can lead to scouring of the pipe lining material or increase the chances of a valve failure. Increased velocities contribute to increased head loss, usually resulting in a less efficient water distribution system. Higher velocities may be acceptable for short-term operation, such as when needed for fire-flow, but otherwise should be lower where practical. The planning scenarios used to analyze the Clearlake System for pressure deficiencies were also used to evaluate the velocities under the same demand periods (ADD, MDD, and PHD). The velocity criteria used to evaluate the distribution system for each demand period were defined in TABLE 6-1.

As stated in footnote ‘a’ of TABLE 6-1, “If velocity or headloss in a pipeline exceeded the criteria listed but did not result in low pressures in the system, the pipeline was not recommended for replacement.” Thus, pipelines with velocities above the criteria identified in TABLE 6-1 but below 10 fps were reviewed for excessive pressure loss resulting in low pressures or excessive energy use. Where the velocities did not appear to contribute to pressure problems or excessive pumping, then no deficiency was identified and no improvement was proposed.

The numbering system used in deficiency tables below is a series of three numbers. The first number indicates the planning period: 1 for the existing system and 2 for the 2035 system. The second number indicates the deficiency number, which starts at 1 and increases by 1 for each deficiency identified. The third number identifies the improvement alternative (zero is reserved for the deficiency identification). Proposed improvements to correct the deficiency are numbered starting at 1. Therefore, the alternative number 1.2.3 would be used to identify the third proposed alternative for the second deficiency in the existing system. (Note: Deficiencies identified may not start with the number 1.1.0 if there are deficiencies identified in a prior section of this master plan.)

TABLE 6-3 Existing System Deficiencies and Recommend Improvements for ADD, MDD, and PHD

Deficiency/ Alternative Number	Location	Deficiency	Recommended Improvement
1.1.0	**Oakcrest Reservoir Zone**	**MDD pressure (<40, >125)**	
1.1.1	Pioneer Dr, w/o Dellwood Dr		---
1.1.2	Crestview Dr/San Joaquin Ave, Merced Ave to Mira Vista Rd		Expand Oakcrest Booster Zone to include Crestview Dr/San Joaquin Ave
1.2.0	**Sampson Reservoir Zone**	**MDD headloss**	
1.2.1	6-inch AC, Sonoma Ave, 7^{th} to Fresno St (easterly discharge from Sonoma Plant)		Install Approximately 400 LF of 8-inch PVC in Sonoma Ave, from 7^{th} to Fresno St, south to Fair Oak
1.3.0	**Sampson Resevoir Zone**	**MDD Velocity**	
1.3.1	6-inch AC, Sonoma Ave, 8^{th} to 9^{th} St (westerly discharge from Sonoma Plant)		Install Approximately 300 LF of 8-inch PVC in Sonoma Ave, from 8^{th} to 9^{th} St

SECTION 7

Water Quality Evaluation

The purpose of this section is to provide documentation of Golden State Water Company's (Golden State Water) water quality assessment for the Clearlake System. Water quality of local surface water was evaluated based on current federal and state standards and rules.

7.1 Current Status of Drinking Water Quality

The Clearlake System is supplied solely from surface water provided by Clear Lake. Surface water from Clear Lake is pumped, through the Lakeshore Booster Station, to the Sonoma Water Treatment Plant. The drinking water quality of the Clearlake System must comply with the Safe Drinking Water Act (SDWA), which is composed of primary and secondary drinking water standards regulated by the U.S. Environmental Protection Agency (EPA) and the State Water Resources Control Board, Division of Drinking Water.

Water quality sampling is performed at the sources to ensure compliance with all regulatory standards. Sources are sampled per the requirements of Title 22 of the California Code of Regulations. Monitored constituents include general mineral, general physical, inorganic, volatile organic, synthetic organic, and radiological compounds/chemicals. The frequency of monitoring depends on the parameter being tested and the concentration of the constituent in the source. Frequencies range from monthly to once every 9 years.

Distribution system water quality monitoring is performed for several water quality parameters in the Clearlake System, including general physical parameters, presence of coliform bacteria, chlorine residual, disinfection byproducts, orthophosphate, and corrosivity of the water by monitoring lead and copper levels at customers' water taps. The distribution system is tested weekly for the presence of coliform bacteria at representative locations throughout the system; disinfection byproduct samples are collected on a quarterly basis. All monitoring parameters and levels currently meet drinking water standards.

7.2 Surface Water Quality

Clear Lake's unique natural features and extensive recreational activities create challenges with respect to maintaining high water quality. Although the lake has a large surface area, its shallow depths make it susceptible to changes in nutrient and sediment loading, and temperature. Clear Lake is California's largest freshwater lake and attracts large numbers of recreational enthusiasts, including boaters, swimmers, and campers. These activities represent potential threats to water quality.

During storm events, nutrient rich sediments are carried to Clear Lake by its tributary streams. These nutrients, especially phosphorus, contribute to the seasonal growth of aquatic plants and algal blooms, particularly blue-green algae (cyanobacteria). When algae float to the water surface, they are driven by wind and currents into large mats that die and contribute to significant odor problems. Storm runoff also contributes to high turbidities that directly impact water treatment operations at the Sonoma plant.

Recreational activities can impact the water quality of Clear Lake in a number of different ways. Two stroke engines on boats and personal watercrafts can emit significant quantities of oil and fuel into the lake which can contribute to taste and odor issues. Bodily contact recreation, such as swimming, can increase fecal coliform where no restroom facilities exist.

The Clear Lake watershed was historically mined for sulfur, mercury, borax, manganese, sand and gravel, and road base rock. Historical water quality data indicates that past mining activities contributed to increased arsenic, mercury and boron levels in the lake. Recent water quality analyses, however, have shown concentrations below the Maximum Contaminant Levels (MCL)s.

Sonoma Water Treatment Plant

The Sonoma Water Treatment Plant, placed into service in 1992, provides conventional treatment. Raw water is pumped from the lake through an intake screen to the Sonoma Water Treatment Plant a half mile away. Treatment of the water includes the following unit processes:

- Pre-oxidation using potassium permanganate
- Injection of PAC (seasonal) for coagulation/flocculation, reduction of cyanotoxins, taste & odor control
- Injection of polymer(s) for coagulation/flocculation
- High and low velocity gradient flocculation basins
- Sedimentation basins
- Injection of a nonionic filter aid polymer
- Filtration through dual media pressure filters
- Absorption using activated carbon contactors
- Injection of zinc orthophosphate for corrosion control
- Post-injection of Sodium Hypochlorite to provide required disinfection

Due to recreational activity on the lake, an increased Giardia disinfection activation by a minimum of 1-log must be practiced when monthly *E. coli* counts exceed 1000 MPN/100ml. Water storage and chlorine contact time is provided by a 200,000-gallon clearwell. Water produced by the Sonoma Plant meets current drinking water standards.

7.3 Water Quality Evaluation

The following discussion provides information on the relevant water quality evaluation rules for the Clearlake System, including:

- Long Term 2 Enhanced Surface Water Treatment Rule
- Stage 2 Disinfectants and Disinfection By-products Rule
- Microplastics
- Sonoma Surface Water Treatment Plant

7.3.1 Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR, published by the USEPA on January 5, 2006, is designed to control risks associated with microbial pathogens, especially *Cryptosporidium*. The rule requires surface water systems serving less than 10,000 people to select from the following two options to comply with source water monitoring requirements:

- Systems may conduct *E. coli* monitoring first and based on those results, the system may or may not need to conduct *Cryptosporidium* monitoring, or
- Systems may go directly to *Cryptosporidium* monitoring.

Prior monitoring data that meets the grandfathering requirements established under the LT2ESWTR may be submitted in lieu of additional monitoring. *E. coli* data for samples collected between January and December of 2007 of the raw source water at the Sonoma Water Treatment Plant were submitted to CDPH in November of 2008. Based on these results, the Clearlake System is not required to conduct further *Cryptosporidium* monitoring.

Systems are classified into a "bin" based on the source water monitoring results. The bin classification determines whether further treatment is required. The Clearlake System is classified in Bin 1, and no additional *Cryptosporidium* treatment is required.

7.3.2 Stage 2 Disinfectants and Disinfection By-products (Stage 2 DBP) Rule

On January 4, 2006, the EPA published the Stage 2 Disinfectants and Disinfection By-products Rule (Stage 2 DBP Rule) in the Federal Register (71 FR 388). Under the Stage 1 Rule, results from DBP sampling are averaged across the entire distribution system. Under the Stage 2 DBP Rule, the results of sampling will be averaged quarterly at each sampling site and a Locational Running Annual Average (LRAA) of the results computed. The LRAA at each location must be below 80 micrograms per liter (μg/L) for TTHM and 60 μg/L for HAA5. Stage 2 DBP Rule requirements were implemented in October 2013 for the Clearlake System.

In December 2014, the LRAA at Oakcrest Sample Station reached 71 ppb, with a maximum of single sample in July at 110 ppb. In response, Golden State Water installed blowers and mixers in both distribution tanks to volatize and remove TTHMs. As well as installed an aerator in Oakcrest. Since installation, TTHMs have been reduced by approximately 60 ppb in the distribution system. HAA5 levels are about 45 ppb, which is 75% of the MCL at 60ppb. Additional system improvements may be necessary if DBP levels rise.

7.3.3 Microplastics

On September 28, 2018, Senate Bill No. 1422 was filed with the Secretary of State, adding section 116376 to the Health and Safety Code, and requiring the State Water Board to adopt a definition of microplastics in drinking water on or before July 1, 2020, and on or before July 1, 2021, to adopt a standard methodology to be used in the testing of drinking water for microplastics and requirements for four years of testing and reporting of microplastics in drinking water, including public disclosure of those results. Future water quality monitoring may be needed as implementation of this law occurs.

7.3.4 PFAS

Per- and polyfluoroalkyl substances (PFAS) are a varied and sundry group of compounds used in a variety of industrial and commercial applications including fire-fighting foams, clothing, metal plating, and upholstery.

As a small public water system, the Clearlake System was not required to be monitored for PFAS including PFOA and PFOS as a part of the third unregulated contaminant monitoring rule (UCMR3).

The following outlines regulatory requirements for PFAS:

- In 2015, the EPA released a health advisory for two PFAS compounds, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), at a combined total of 70 nanograms per liter (ng/L).
- In July 2018, DDW set a notification level for PFOS of 13 ng/L and PFOA of 14 ng/L with a recommendation for source treatment or removal from service at a combined 70 ng/L. In the absence of a federal MCL, several states are in the process of developing MCL for PFAS.
- In March 2019, DDW issued the first phase of mandatory PFAS testing orders for public water systems across California based on proximity to: airports with fire training/response sites and previous PFOA/PFOS detections. The Clearlake water system did not receive a mandatory testing order in the first phase.
- In August 2019, DDW revised the notification levels from 13 ng/L to 6.5 ng/L for PFOS and from 14 ng/L to 5.1 ng/L to PFOA.

The regulatory requirements for PFAS are expected to develop over the next one to three years. Regulations for this emerging contaminant will be closely monitored by Golden State Water.

7.3.5 Sonoma Surface Water Treatment Plant

Study

Sonoma Surface Water Treatment Plant is 28 years old. In 2017, an unexpected change in Clear Lake water quality (increased iron, manganese; pH changes; low ORP; presence of ammonia) resulted in emergency 24/7 operation of the Sonoma Surface Water Treatment Plant. Staff with over 20 years of Clear Lake surface water treatment expertise never had experienced such an event before. The State Water Resource Control Board regulators also did not have experience with what was occurring. During the event, lake water quality was so poor at times, it was not treatable with the capital equipment at the plant. Golden State Water Company required the emergency interconnection to be activated to ensure the water system did not run out of water. There were approx. 80 customer complaints during this two-week event.

The Sonoma Surface Water Treatment Plant was designed and constructed prior to modern water quality regulatory standards (such as the Stage 1 and 2 Disinfectants and Disinfection Byproducts Rules, Enhanced Surface Water Treatment Rule, US EPA Cyanotoxin action levels) and the diurnal lake conditions. Golden State Water Company should conduct a study to evaluate existing treatment processes to determine if there are any capital improvements to ensure the Clearlake Water System maintains compliance with existing and emerging regulations.

Filters

During a 2014 inspection of the filters by Carbon Activated Corporation, it was identified that the lower laterals should be replaced with longer laterals to improve flow distribution through the filter media. Per the American Water Works Association "Filtration is a key unit process for removal of microbial contaminates therefore high levels of performance are essential from each filter on a continuous basis". Also, the State Water Resources Control Board requires that filtration rates do not exceed 3.0 gpm/ft^2; therefore, even flow distribution is important. The laterals should be replaced as soon as funding is available.

7.3.6 Assembly Bill 1668

This State Assembly Bill sets an indoor water usage limit of 55 gallon per day per person. The Bill also requires the State Water Resources Control Board, in coordination with the Department of Water Resources to establish long-term standards for the efficient use of water and performance measures for commercial, industrial, and institutional water use on or before June 30, 2022. If the implementation of this legislation results in significant reduction of water usage, it may result in increased water age in the distribution system. This may cause corresponding water quality challenges such as low chlorine residual and nitrification. Future water quality studies may be needed as implementation of this law unfolds over the next two to five years.

7.4 Recommended Improvements

The water quality concerns that were discussed in the previous sections are summarized in TABLE 7-1.

TABLE 7-1 Recommended Improvements to Address Water Quality Concerns

Alternative Number	Alternative Description
1.4.0	**Sonoma WTP improvements**
1.4.1	Conduct a study of the Sonoma Surface Water Treatment Plant to determine capital improvements to ensure compliance with existing and emerging regulations; determine best treatment with regard to water quality of lake
1.4.2	Replace lower filter laterals

SECTION 8

System Condition Assessment

The purpose of this section is to provide documentation of GSWC's system condition assessment effort for the Clearlake System. This section is organized as follows:

- Previous system condition assessment efforts
- Updated condition assessments

8.1 Previous System Condition Assessment Efforts

More than 10 years ago, GSWC conducted several facility condition assessment efforts, working with multiple engineering consulting companies to develop a complete condition assessment for each of the Company's systems. Facilities in the Clearlake System were addressed in this effort.

Generally, the purpose of these studies was to inspect and evaluate existing facilities to determine if upgrades would produce significant benefit to offset expenditures. These studies included the following information:

- Evaluations of the safety of the facilities
- Outstanding code violations
- A general evaluation of condition and reliability

8.2 Updated Condition Assessments

For this Master Plan, GSWC Operations and Planning personnel reviewed the condition of plant facilities and pipeline data within the Clearlake System in order to identify the facilities requiring upgrade or replacement. For the pipeline conditional assessments, no specific recommendations were made based solely on condition, but age and material were considered along with pipeline leaks/breaks and input from operations staff.

8.2.1 Facility Condition Review

The purpose of this review was to identify plant improvement projects based on the following:

- Operational needs and requests
- Common items that are not installed at all plant sites
- Recommendations from the previous condition assessments that were not installed

GSWC reviewed each of the following elements to identify potential recommended improvements at each facility:

- Electrical
- Mechanical
- Structural
- Other site improvements

TABLE 8-1 summarizes the recommendations that were developed as a result of the system condition assessment review.

TABLE 8-1 2011 Condition Assessment Plant Projects

Alternative Number	Facility	Project Description	Reason	Priority Category
1.5.0	Sonoma WTP	Replace backwash pumping system	Utilize system water as the source of water to clean filters instead of settled water, which takes plant completely off line during backwash	Short-term
1.6.0	Sonoma WTP	Change out GAC & recoat interior of contactors	GAC needs to be changed out every 3 years; interior epoxy failure showing rust	Short-term
1.7.0	Sonoma WTP	Replace filter media	Filter media needs to be changed out every 7-10 years	Short-term
2.1.0	Manchester Plant	Install SCADA	Current pump and flow control requires experience which is easily forgotten due to infrequent use	Long-term

8.2.2 Pipeline Condition Review

In addition to facility condition, GSWC monitors distribution system condition through the tracking of pipeline leaks/breaks on an annual basis; FIGURE 8-1 is a map of the leaks in the Clearlake System from 2014 to 2018. This information was used, along with additional risk assessment analysis, to make recommendations regarding potential CIP projects and in the prioritization of those projects. (See GSWC's *Pipeline Management Program Report* and *Risk Based Asset Management Program Report*.)

As part of the overall main replacement program for the Clearlake System, GSWC is striving to replace old, deteriorating and undersized steel mains, as these mains contribute to the high number of leaks in the Clearlake System. The replacement of these mains will occur over multiple rate cycles, with the goal of ultimately replacing all ~9 miles of existing steel main.

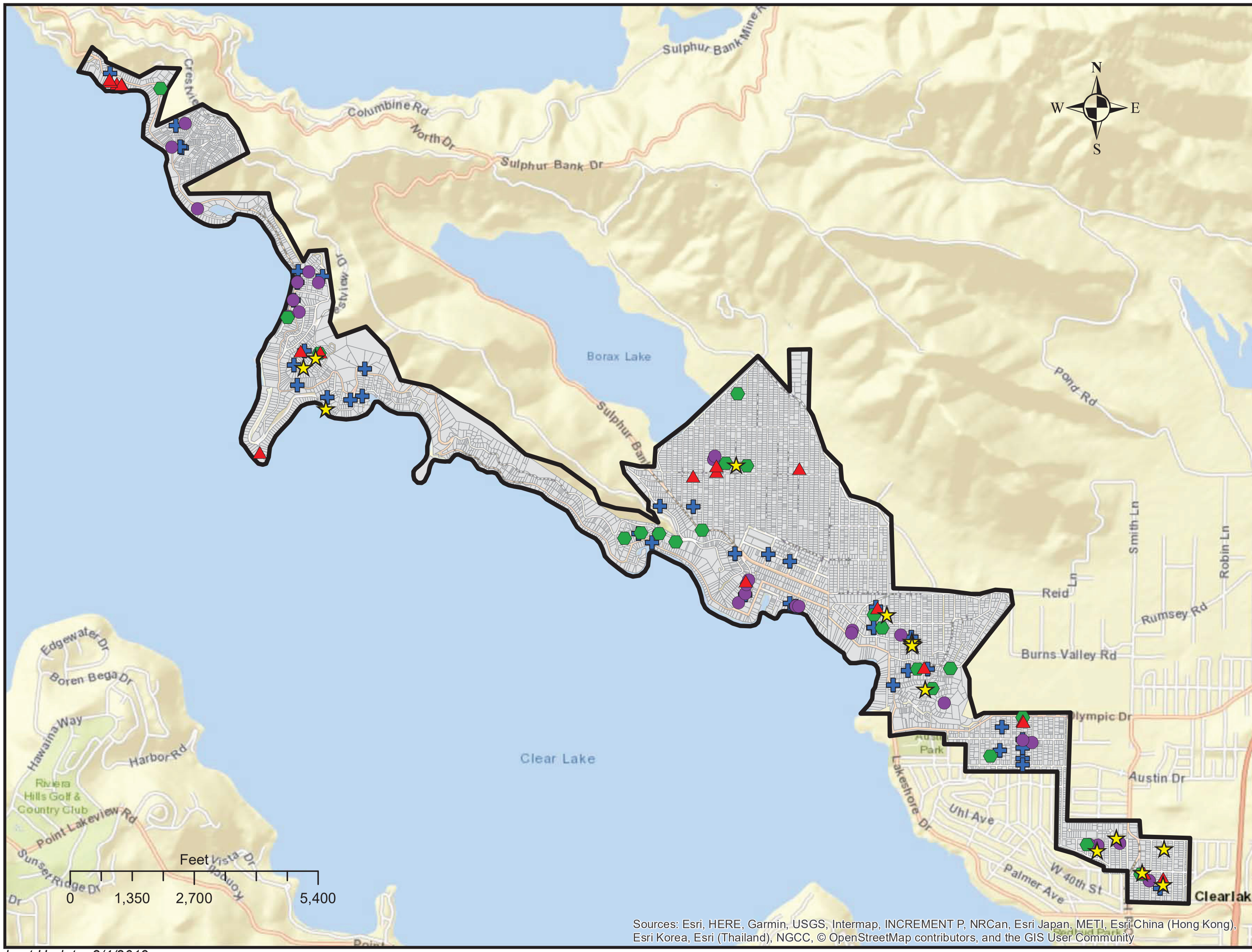
TABLE 8-2 2011 Condition Assessment Pipeline Projects

Alternative Number	Recommended Improvement	Reason	Priority Category
1.8.0	Buckeye St, Austin to Olympic, Approximately 1,000 LF of 8-inch PVC	Address leaks, hydraulic deficiency, age, and condition of existing 2" STL pipeline	Short-term
1.9.0	Lower Lakeshore easement to Lakeshore Dr, Approximately 300 LF of 6-inch PVC	Loop through recently acquired easement	Short-term
1.10.0	Hill Ave., West 40th to Old Hwy, Approximately 1,400 LF of 6-inch PVC	Address leaks, age, and condition of existing 2" STL and 4"STL pipeline	Short-term
1.11.0	Olympic Drive, Olive to Redwood, Approximately 2,500 LF of 8-inch PVC	No water main in Olympic Drive, dead end mains throughout the grid and has led to sediment build up, chlorine degradation, and taste and odor	Short-term
1.12.0	Huntington Ave, Lakeshore to Pomo and	Address leaks and hydraulics; age and	Short-term

	Morgan St, Huntington to Scenic, Approximately 1,800 LF of 8-inch PVC	condition of existing 2" STL and 4"STL pipeline	
1.13.0	Arrowhead Rd, Vista St & Woodland Dr, Approximately 2,200 LF of 8-inch PVC	Eliminate dead-ends, close loop, replace small steel mains; provide redundant supply	Short-term
2.2.0	Interconnection with Konocti County Water District, SE end of Clearlake System	Redundant supply in case of emergency	Long-term

Figures

CLEARLAKE SYSTEM LEAK MAP 2014 - 2018



Year & Number of Leaks

- 2014 - 44 Leaks
- 2015 - 32 Leaks
- 2016 - 21 Leaks
- 2017 - 19 Leaks
- 2018 - 15 Leaks

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SECTION 9

Capital Improvement Program

The capital improvement program (CIP) is an essential component of this water master plan. The CIP summarizes recommended facilities, and establishes the priority and timing of necessary improvements. The recommended improvements were analyzed and evaluated in the previous sections of this report.

The recommended improvements were prioritized into two categories—short-term (existing system) or long-term (2040 system)—to identify when these improvements are required. The project selection and prioritization process considered various issues, including existing deficiencies, projected demands, water quality, regulatory compliance, reliability and facility condition.

9.1 Cost Estimation

No cost estimates are included in this master plan, as the final costs of a project, and the project's resulting feasibility, will depend on actual labor and material costs, inflation, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Prior to design and construction of any recommended project in this master plan, a detailed project cost estimate will be created.

9.2 Project Prioritization

The following descriptions define how projects were prioritized into one of the two categories:

- **Short-term improvement projects** were based on deficiencies identified in the existing system. Deficiencies included supply and storage, hydraulic, condition assessment, and water quality. Operational improvements were included as a short-term improvement only when a significant short-term benefit was identified.

- **Long-term improvement projects** are based on deficiencies identified beyond the short-term planning years through the year 2040. The water system was assumed to be built out by the year 2040. The long-term improvements are typically projects necessary to meet future demands and replace or rehabilitate aging infrastructure.

9.3 CIP Projects

TABLE 9-1 lists the recommended improvements for the Clearlake System. Each project is assigned a unique identification number and a priority: short-term or long-term. Short-term pipeline projects are shown on FIGURE 9-1.

TABLE 9-1 Summary of Recommend CIP Projects

Project ID	Recommended Improvement	Improvement Type	Priority Category
1.3.1	Sonoma Ave, 8th St to 9th St Main Replacement	Hydraulic	Short-term
1.4.1	Sonoma WTP Facility alternatives study	Water Quality	Short-term
1.5.0	Replace backwash pumping system at Sonoma WTP	Conditional Assessment	Short-term
1.6.0	Change out GAC & recoat interior of contactors at Sonoma WTP	Conditional Assessment	Short-term
1.7.0	Replace filter media and lower filter laterals (Water Quality Project ID 1.4.2) at Sonoma WTP	Conditional Assessment	Short-term
1.8.0	Buckeye St, Austin to Olympic Main Replacement	Conditional Assessment	Short-term
1.9.0	Lower Lakeshore easement to Lakeshore Dr Main Installation	Conditional Assessment	Short-term
1.10.0	Hill Ave, West 40th to Old Hwy Main Replacement	Conditional Assessment	Short-term
1.11.0	Olympic Dr, Olive to Redwood Main Replacement	Conditional Assessment	Short-term
1.12.0	Huntington Ave, Lakeshore to Pomo and Morgan St, Huntington to Scenic Main Replacement	Conditional Assessment	Short-term
1.13.0	Arrowhead Rd, Vista St & Woodland Dr Main Replacement	Conditional Assessment	Short-term
2.1.0	Install SCADA at Manchester Plant	Conditional Assessment	Long-term
2.2.0	Interconnection with Konocti County Water District	Conditional Assessment	Long-term

9.4 Additional Considerations

As part of the overall main replacement program for the Clearlake System, GSWC is also striving to install new water lines to replace old, deteriorating and undersized steel pipelines located throughout the system. Installation of new mains will continue as part of the long-term pipeline replacement/management program in conformance with KANEW replacement recommendations.

Figures

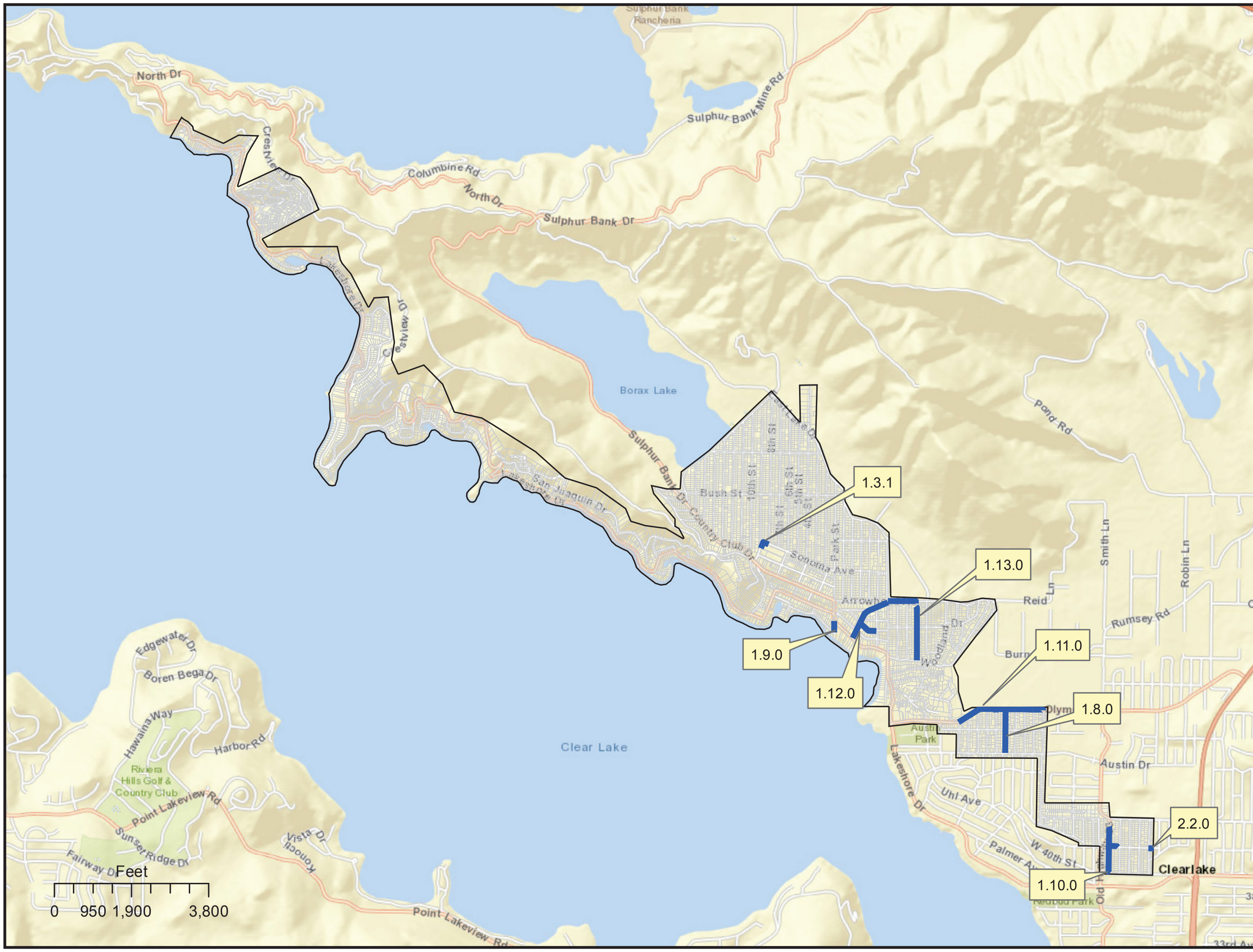

FIGURE 9-1
PROPOSED PIPE REPLACEMENT PROJECTS
GSWC REGION I WATER MASTER PLAN
CLEARLAKE SYSTEM

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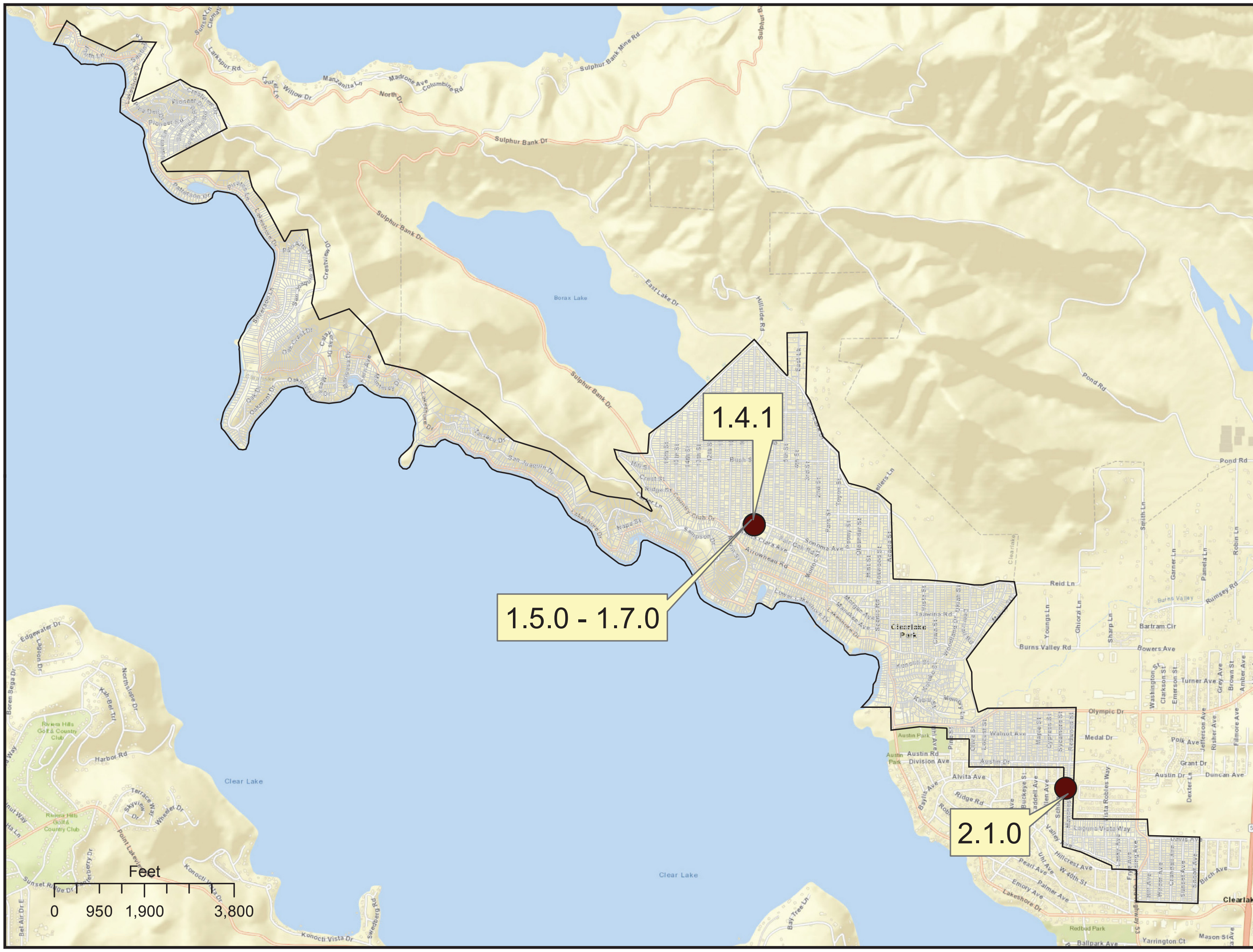

FIGURE 9-2
PROPOSED PLANT REPLACEMENT PROJECTS
GSWC REGION I WATER MASTER PLAN
CLEARLAKE SYSTEM

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SECTION 10

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